NASA Technical Memorandum 4582

Experimental Study at Low Supersonic Speeds of a Missile Concept Having Opposing Wraparound Tails

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November 1994

This publication is available from the following sources:

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Abstract

A wind-tunnel investigation has been performed at low supersonic speeds (at Mach numbers of 1.60, 1.90, and 2.16) to evaluate the aerodynamic characteristics of a missile concept capable of being tube launched and controlled with a simple one-axis canard controller. This concept, which features an axisymmetric body with two planar canards and four wraparound tail fins arranged in opposing pairs, must be in rolling motion to be controllable in any radial plane with the planar canards. Thus, producing a constant rolling moment that is invariant with speed and attitude to provide the motion is desirable. Two tail-fin shaping designs, one shaved and one beveled, were evaluated for their efficiency in producing the needed rolling moments, and the results showed that the shaved fins were much more desirable for this task than the beveled fins.

Introduction

Tactical missiles that do not require high maneuverability (air-to-ground or antitank) can make use of more simple stability and control techniques than are required for missiles needing high maneuverability (air-to-air or surface-to-air). One such simplified technique is to have the missile airframe rolling in flight. This spinning motion not only enhances stability but also allows the missile to be controlled in any radial plane by small planar canards driven by a single-axis controller (i.e., no differential deflections). Another desirable feature for this class of missile is the ability to fold all the fins, which could include canards, wings, or tails, into or around the body for compact tube storage. The fins would then be deployed as the missile exits the launch tube. Examples of current systems using folding fins can be found in reference 1 and include: (1) the Redeye missile, which has fins that fold rearward; (2) its replacement, the Stinger missile, which has short-span tail fins that fold into a necked-down region of the body; and (3) the TOW missile, which has wings that fold rearward and tails that fold forward.

Another method of accomplishing compact tube storage for tail fins is to have them wrapped around the body circumferentially before and during launch. The aerodynamics of wraparound tail fins is thus of great interest for this class of missile and has been the subject of numerous studies for many years by the Department of Defense (refs. 2–4), NASA (refs. 5 and 6), and others (refs. 7–9).

The traditional wraparound-fin configuration has four curved fins mounted in a cruciform arrangement, with each fin curving in the same direction and wrapped around approximately 25 percent of the body circumference before deployment. The previous studies cited in the aforementioned references were all conducted using this traditional arrangement, which is illustrated in the sketch in figure 1(a). This arrangement produces a nonsymmetric configuration and is known to produce nonlinear and sometimes erratic aerodynamics, especially in rolling moment, even at small angles of attack. (See refs. 2–5.) One current system that employs the traditional wraparound folding arrangement in a design consisting of three tail fins is the Dragon missile (ref. 1).

In the present study, a novel fin arrangement designed to overcome these undesirable aerodynamic features is investigated. This arrangement has wraparound tail fins mounted in opposing pairs, as shown in the sketch in figure 1(b). When unopened, the opposing fin pairs overlap and fit inside a body cavity to allow storage within a constant-diameter launch tube. This arrangement has several potential aerodynamic advantages over the traditional wraparound arrangement, and these are listed as follows:

1. Because of overlapping, the fin spanwise arc length is not limited to 25 percent of the body circumference.

2. Symmetry on the model is established, which should eliminate some of the undesirable aerodynamic characteristics of the traditional wraparound fins.

3. Deployment of these fins by blasting them into the open position can be accomplished by using two side-mounted scarfed nozzles located underneath the overlapping fins, whereas four such nozzles would be required for the traditional wraparound fins.

This opposing-pair arrangement retains the wraparound concept while producing symmetry on the model. Because all the fin surfaces are mounted streamwise in a symmetric arrangement and differential deflections are not permitted by the single-axis canard controller, no inherent roll is expected on the configuration. This arrangement thus does not produce the desirable steady roll rate that is necessary for this configuration to be controlled by the planar canards. One method of producing the necessary roll is to shape the leading and trailing edges of the tail fins. In previous studies, beveling of the fin leading edges has been used. In this paper, both shaved and beveled leading edges are examined for their effectiveness in creating this desired roll.

The purpose of this paper is to experimentally examine at low supersonic speeds the static aerodynamic stability and control characteristics of a tactical missile concept that incorporates the planar canards, opposing pairs of wraparound tails, and tail-shaping features mentioned previously. This configuration was designed for a peak Mach number of about 2.0. This force and moment test was conducted in the low Mach number test section of the Langley Unitary Plan Wind Tunnel at Mach numbers of 1.60, 1.90, and 2.16 at a unit Reynolds number of 2.0×10^6 per foot.

Symbols

The measurements and calculations in this experiment are made in U. S. Customary Units, and force and moment coefficients are referred to the body-axis system. The capitalized expression in parentheses next to the symbol is the computer-printout equivalent of that symbol that is used in the aerodynamic data presented in tables 2–28.

C_A	(CA)	axial-force coefficient, $\frac{F_A}{qS_{\text{ref}}}$
$C_{A,C}$	(CAC)	chamber axial-force coefficient, $\frac{F_{A,C}}{qS_{\text{ref}}}$
C_l	(CLB)	rolling-moment coefficient, $\frac{M_X}{qS_{\text{ref}}d}$
C_m	(CM)	pitching-moment coefficient, $\frac{M_Y}{qS_{\text{ref}}d}$
C_N	(CN)	normal-force coefficient, $\frac{F_N}{qS_{\text{ref}}}$
C_n	(CNB)	yawing-moment coefficient, $\frac{M_Z}{qS_{\text{ref}}d}$
C_Y	(CY)	side-force coefficient, $\frac{F_Y}{qS_{\text{ref}}}$
d		body diameter, 2.60 in.
F_A		model axial force, lb
$F_{A,C}$		chamber axial force, $(p_c - p_\infty)S_{\text{ref}}$, lb
F_N		model normal force, lb
F_Y		model side force, lb
M		free-stream Mach number
M_X		model rolling moment, in-lb
M_Y		model pitching moment, in-lb
M_Z		model yawing moment, in-lb
p_c		chamber pressure, lb/in^2
p_∞		free-stream static pressure, lb/in^2
q		free-stream dynamic pressure, lb/in^2
r		radius of curvature, in.
S_{ref}		model reference area, $\frac{\pi d^2}{4}$, 5.31 in^2
α	(ALPHA)	model angle of attack, deg
δ		canard-deflection angle, positive leading edge up, deg
ϕ		model roll angle, positive right wing down, deg

Configuration code:

B	body
C1	canard with trailing-edge plate
C2	canard without trailing-edge plate
T1	tail fins with shaved edges
T2	tail fins with beveled edges

Abbreviations:

Conf.	configuration
dia.	diameter
MS	model station, in.
rad.	radius

Tests and Procedures

Model

The baseline configuration consists of an axisymmetric body with a blunt nose, planar canards, and

wraparound tails arranged in opposing pairs. Figure 2 shows a photograph of this baseline configuration mounted in the low Mach number test section of the Langley Unitary Plan Wind Tunnel. A three-view sketch showing pertinent dimensions of the model is presented in figure 3. The cavities in the body between the opposing pairs of wraparound tails were designed to simulate side-mounted scarfed nozzles and to allow room for folding of the opposing pairs of tail fins. In this investigation, in which only fixed-fin hardware was used, the fins were attached to the body to simulate an unfolded configuration. For configuration buildup data, the tail fins were removed and the mounting holes were filled, but no attempt was made to fair over the body cavities.

The canards of the baseline configuration had small plates attached perpendicularly along the trailing edges. These plates were intended to simulate a free-oscillation suppression device for these canards. The canards would have a tendency to oscillate unless restrained aerodynamically because the hinge line was located near the leading edge and the canards were free to oscillate except during roll orientations when they would be actuated. No attempt was made in this study to allow the canards to oscillate as they would in flight, and thus dynamic effects could not be measured. As a result, no conclusions can be drawn concerning the efficiency of these plates as free-oscillation suppression devices.

The forward hinge-line location on these canards was designed to allow them to be folded aft into the body for compact storage. An alternate set of canards without the trailing-edge plate was tested to study the effects of the plate. Canard dimensions are shown in figure 4, and a photograph of both sets of canards is shown in figure 5.

Each tail fin of the baseline configuration contained a shallow shaved region along its leading and trailing edges that was designed to produce the rolling moments needed for control of this configuration with the planar single-axis canards. For each set of opposing fins, one fin was made slightly smaller than its mate to simulate the ability of those fins to fold together around the body for storage. Sketches of the aft end of the model and of the baseline tail fins are shown in figure 6.

The shaved regions on the tails are shown as the shaded areas in figure 6. The streamwise slope of these regions was about 4°, which resulted in the length of the shaved region ranging from about 45 percent of the fin chord at the root to about 10 percent at the tip. Fins 1 and 3 were shaved near the leading edge of the convex surface, as seen in the figure, and near the trailing edge of the concave surface (not shown). Fins 2 and 4, on the other hand, were shaved in the reverse pattern so that rolling moments in the same direction would be generated on all four fins.

Previous research (ref. 2) on traditional wraparound tails indicated that incorporating sharp bevels along the leading edges does not produce reliable rolling moments. To investigate the relative efficiency of the shaved-fin design, an alternate set of tails was tested that incorporated sharp 45° bevels along the leading edges. The length of the bevel ranged from about 2.8 percent of the tail chord at the root to about 8.4 percent at the tip. For these alternate fins, the bevels were located on the leading edge only and were arranged to generate rolling moments in the same direction on all four fins. A photograph of the shaved and beveled fins is shown in figure 7.

Wind Tunnel

This investigation was conducted in the low Mach number test section of the Langley Unitary Plan Wind Tunnel. This tunnel is a variable-pressure, continuous-flow facility with two test sections that cover a Mach number range from 1.47 to 4.63. Mach number is controlled by an asymmetric sliding block which forms the floor of the nozzle and test section. The low-speed test section has a Mach number range from 1.47 to 2.90. The test section is approximately 4-ft wide by 4-ft high by 7-ft long, and it is formed by the downstream section of the nozzle. A more detailed description of this facility can be found in reference 10. A schematic drawing of the Langley Unitary Plan Wind Tunnel complex, taken from reference 10, is shown in figure 8.

Measurements and Corrections

Aerodynamic forces and moments on this model were measured by a six-component strain gauge balance that was housed inside the body of the model. This balance had a nominal rated accuracy of ±0.5 percent of the full-scale value on each component. For the test conditions of this study, this resulted in the following accuracies in the data coefficients: $C_N = \pm 0.090$, $C_A = \pm 0.024$, $C_m = \pm 0.116$, $C_l = \pm 0.012$, $C_n = \pm 0.046$, and $C_Y = \pm 0.060$.

The balance was mounted on a sting, which was, in turn, attached to the permanent tunnel-support mechanism downstream of the model. (See fig. 2.) Model angle of attack was corrected for deflection of the balance and sting due to aerodynamic loads and for test section flow misalignment.

Pressures inside the model were measured by two pressure tubes located inside the balance chamber. The model internal diameter was beveled to the outer diameter at the base of the body to allow the internal pressure to act over the entire base. (See fig. 6.)

Axial-force data were corrected for the difference between the internal chamber pressure and free-stream static pressure ($C_{A,C}$). The model moment center was located on the body centerline at 53.1 percent of the body length, or 17.51 in. aft of the model nose.

To induce boundary-layer transition to turbulent flow, transition strips were applied to the model by using the technique established in reference 11. These strips consisted of No. 50 sand grains (0.0128 in.) sprinkled in acrylic plastic. The strips were about 0.062 in. wide and were located about 1.20 in. aft of the nose and 0.40 in. aft of the leading edges (measured streamwise) on all fin surfaces.

Test Conditions

This investigation was conducted primarily at free-stream Mach numbers of 1.60 and 1.90, although additional tail-fin shaving effects were obtained at a Mach number of 2.16. For all runs, the Reynolds number was 2×10^6 per foot, and the model angle of attack ranged from about -4° to 20°.

In flight this configuration would be in continuous rolling motion, but for this investigation, the model was tested in a static condition in which the roll angle was fixed. The test was conducted primarily at model roll angles of 0°, 45°, and 90°, with some additional testing of the baseline configuration at 22.5° and 67.5°. Canard-deflection angles ranged from -15° to 15° in 5° increments.

Presentation of Data

The six-component model force and moment data obtained in this investigation were reduced to coefficient form in the body-axis system and are tabulated in this paper. Table 1 shows a summary of the data locations in the subsequent tables as a function of the test variables, and the data listings are contained in tables 2–28. Selected data from these tables have been plotted and are analyzed in the following sections of the paper to explore the effects of the test variables.

Results and Analysis

Analyses of the data obtained in this investigation are made by using plots of selected data from tables 2–28. The effects of the test variables are examined by analyzing graphs of normal-force, axial-force, pitching-moment, and rolling-moment coefficients as a function of angle of attack. Because this configuration has planar canards and is expected to fly at angles of attack below about 10°, the lateral loads are expected to be small, and thus no analyses of the side-force and yawing-moment data are made in this paper.

In figures 9–13, all four of the primary aerodynamic parameters are plotted on the same page, and all graphs are plotted to the same scale to facilitate comparisons among the test variables. Figure 14 is a summary of the rolling-moment coefficients plotted with magnified scales.

Component Buildup

The effects of the model components that make up the complete baseline configuration (BC1T1), are analyzed by comparing component buildup data at $\phi = 0^\circ$ with undeflected canards for $M = 1.60$ and 1.90, as seen in figure 9. These data show that the rolling moment on this configuration is coming from the tail fins. The body and canards do not contribute to the rolling moment because of their symmetry. The pitching-moment data show that the most unstable combination of components is the body-canard combination, as would be expected, and that the body alone is also unstable. In contrast, the body-tail combination is very stable except at the higher angles of attack. The body-canard-tail configuration is slightly stable at $M = 1.60$ and slightly unstable at $M = 1.90$. Hence, for the expected supersonic flight regime of this configuration, near-neutral stability exists, and thus this configuration would not need large control surfaces to provide maneuverability.

The addition of the canards to the body results in small increases in both normal and axial forces, whereas the addition of the tails results in a much larger increase. The largest normal and axial forces were created by the complete body-canard-tail configuration.

Effect of Canard Trailing-Edge Plate

Figure 10 shows the effects of the canard trailing-edge plate for $\delta = 0^\circ$ and $\phi = 0^\circ$ at $M = 1.60$ and 1.90. In order to isolate the plate effects, tail-off data for the two canard designs are shown. The only noticeable effect of the plate occurs in the axial-force data. The addition of the plate adds only about 0.02 to the axial-force coefficient, and this value stays

fairly constant with angle of attack and Mach number. The other parameters show a negligible effect of the plate.

Effect of Roll Angle

Because this configuration is designed to spin in flight, the effect of roll angle on the aerodynamics is one of the major parameters of interest. Figure 11 shows the effect of roll angle on the baseline configuration at $M = 1.60$ and $\delta = 0°$.

Roll angle is seen to have a strong effect on pitching moment. A systematic change in stability is shown in the data as the model is rolled from 0° to 90°. The pitching-moment curve at $\phi = 90°$ is, in fact, similar to that seen in the body-tail data shown in figure 9(a). At $\phi = 90°$, the canards are in the vertical plane and thus produce no normal force. Hence, the configuration at this roll angle gives pitching moments similar to those seen in the body-tail combination. On the other hand, roll angle has little effect on the normal-force and axial-force coefficients. In fact, the small differences in axial-force coefficient with roll angle seen in figure 11 were traced to differences in the measured chamber pressures.

The rolling-moment coefficients stay in the range from 0.04 to 0.10 at all roll angles up to about $\alpha = 8°$, but at about $\alpha = 10°$, the curves sharply diverge. The rolling moments at $\phi = 22.5°$ at the higher angles of attack were the largest measured in this investigation, and these curves begin to diverge at an angle of attack where vortices should begin to develop over the body and canards. Thus, the erratic trends in rolling moment above $\alpha = 10°$ are probably caused by the tail fins passing through vortices as the model is rolled from 0° to 90°. Because this configuration was designed to fly at $\alpha < 10°$, these erratic trends are not important in this study.

Effect of Canard Deflection

As shown in table 1, the canards were deflected from $-15°$ to 15° in 5° increments in this study. For clarity, only the largest deflection angles ($\pm 15°$) are examined in this section.

Figure 12 shows the effects of canard deflection for the baseline configuration at $\phi = 0°$ for $M = 1.60$ and 1.90. Positive deflection is defined as leading-edge up. The normal-force curves show that positive deflection produces only slightly more normal force than the undeflected canards, and that negative deflection produces slightly less.

At $\alpha = 0°$, both the positive and negative canard deflections show the same increase in axial force caused by the deflected canards, although the trends of the two curves are different with angle of attack. At the lower angles of attack, the positive-deflection data show increasing axial force, whereas the negative deflection data show decreasing values. This trend is due to the fact that for positive canard-deflection angles, the magnitude of the effective deflection angle (δ) is increasing, whereas it is decreasing for negative δ. The effective deflection angle, as determined by the method of reference 12, is about $1.45\alpha + 0.92\delta$ for this configuration.

The pitching-moment data show similar trends for all deflection angles, but the curves are displaced above and below the zero-deflection data. The positive deflection angle, producing a more positive normal force, results in a higher pitching moment; whereas the negative deflection-angle data show a negative increment in pitching moment. A noticeable break occurs in the curve for $\delta = 15°$ at $\alpha \approx 8°$, which is probably due to canard stall as reflected in the C_N loss (with the effective canard angle being about 25°). This break is also seen in the rolling-moment data in which one canard may stall first, but with the exception of this break, very little effect of canard deflection is seen in the rolling-moment data.

The pitching-moment data in figure 12 also show that this configuration is almost neutrally stable at both test Mach numbers throughout the expected flight angle-of-attack range ($\alpha < 10°$), and therefore the small canards on this configuration should be sufficient to provide controllability.

Effect of Tail Shaping

The most interesting aspect of this configuration is the shaping of the tail fins for producing the rolling moments that are needed for control of this configuration. These shaping effects are examined in this section by comparing body-tail data from the two tail designs, termed shaved and beveled. Also, body-alone data are shown to illustrate the individual differences caused by the two tail designs.

These comparisons, which are shown in figure 13 at $\phi = 0°$, are the only comparisons in this study that include data at $M = 2.16$. (The peak Mach number of this configuration is about 2.0.) Very little effect of fin shaping is seen in the normal-force and pitching-moment data. The beveled fins show higher axial force than the shaved fins throughout the angle-of-attack range. These trends are similar at all the test Mach numbers.

The rolling-moment data show a strong effect of fin shaping, and the effect changes with Mach number. As noted in reference 2, the largest pressure

differences between the concave and convex surfaces of wraparound fins occurred near the leading edge, and geometry changes in this leading-edge region could possibly alter the fin loading. Changes in rolling moment were obtained in the present study as a result of the fin shaping in both the leading- and trailing-edge regions.

In order to see this effect more clearly, the rolling-moment data for the two fin-shaping designs at all three test Mach numbers have been combined in figure 14, with two primary effects being apparent from this figure. One effect is that the shaved fins produce much larger rolling moments than are produced by the beveled fins. In fact, the rolling moments for the beveled fins at the lowest test Mach number are in the opposite direction from that desired. This "roll-reversal" effect with decreasing Mach number was also reported in reference 2 with beveled leading edges, and it was explained by the variation of measured pressures in the leading-edge region.

The second effect is that the shaved fins produce rolling moments that are virtually constant with Mach number at angles of attack up to about 10°, whereas the beveled fins produce large variations with both parameters. The variations with Mach number for beveled wraparound fins are similar to those reported in reference 2, which used the traditional cruciform arrangement.

Because producing adequate rolling moments that do not vary with speed or attitude is highly desirable for a rolling missile such as the present configuration, the conclusion can be made that the present configuration would be much simpler to control with the shaved fins than with the beveled fins that were tested in this investigation. By using the roll-damping calculation method described in reference 13, the rolling moments produced in this study by the shaved fins were estimated to be sufficient to generate the roll rates necessary for this configuration to be controllable in flight.

A significant feature is that the favorable rolling-moment characteristics needed for the control of this configuration were produced on the tail fins by fin shaping and not by the opposing-pair, wraparound tail-fin arrangement. Thus, no conclusion can be drawn in this study regarding the aerodynamics of the tail-fin arrangement.

Concluding Remarks

An experimental investigation has been performed at low supersonic speeds (at Mach numbers of 1.60, 1.90, and 2.16) to evaluate the aerodynamic characteristics of a missile concept capable of being tube launched and controlled with a simple one-axis canard controller. The concept features an axisymmetric body with two planar canards and four wraparound tail fins arranged in opposing pairs.

The small canards on this configuration should be sufficient to provide controllability because this configuration was found to be almost neutrally stable. Also, the small vertical plate attached to the trailing edge of each canard, which was intended to simulate a free-oscillation suppression device in flight, increased the axial force slightly, but otherwise it had a negligible effect on the static aerodynamics measured in this study.

This concept must be in rolling motion in flight to be controllable in any radical plane with the planar canards. Thus, producing a constant rolling moment that is invariant with speed and attitude to provide this motion is desirable. Two tail-fin shaping designs, one shaved and one beveled, were evaluated for their efficiency in producing the needed rolling moments. The results showed that the shaved fins were much more desirable for this task than the beveled fins and that the shaved fins produced sufficient rolling moments needed for controllability. No conclusion can be drawn regarding the aerodynamics of the opposing-pair arrangement of the wraparound tail fins of the present configuration.

NASA Langley Research Center
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August 31, 1994

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Table 1. Summary of Data Locations

M	Configuration	δ, deg	Table for ϕ of—				
			0°	22.5°	45°	67.5°	90°
1.60	BC1T1	0	2(a)	2(b)	2(c)	2(d)	2(e)
	↓	5	3(a)		3(b)		3(c)
	↓	−5	4(a)		4(b)		4(c)
	↓	10	5(a)		5(b)		5(c)
	↓	−10	6(a)		6(b)		6(c)
	↓	15	7(a)	7(b)	7(c)	7(d)	7(e)
	↓	−15	8(a)	8(b)	8(c)	8(d)	8(e)
	BC1	0	9(a)		9(b)		9(c)
	BC2	0	10(a)		10(b)		10(c)
	BT1		11(a)		11(b)		11(c)
	BT2		12(a)		12(b)		12(c)
	B		13(a)		13(b)		13(c)
1.90	BC1T1	0	14(a)		14(b)		14(c)
	↓	5	15(a)		15(b)		15(c)
	↓	−5	16(a)		16(b)		16(c)
	↓	10	17(a)		17(b)		17(c)
	↓	−10	18(a)		18(b)		18(c)
	↓	15	19(a)		19(b)		19(c)
	↓	−15	20(a)		20(b)		20(c)
	BC1	0	21(a)		21(b)		21(c)
	BC2	0	22(a)		22(b)		22(c)
	BT1		23(a)		23(b)		23(c)
	BT2		24(a)		24(b)		24(c)
	B		25(a)		25(b)		25(c)
2.16	BT1		26(a)		26(b)		26(c)
	BT2		27(a)		27(b)		27(c)
	B		28(a)		28(b)		28(c)

Table 2. Data for Configuration BC1T1 at $M = 1.60$ and $\delta = 0°$

(a) $\phi = 0°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.32	−0.8516	0.5987	0.2581	0.0836	0.0258	−0.0135	0.1553
−0.31	−0.0607	0.5838	0.0309	0.0884	0.0053	−0.0095	0.1495
3.69	0.7285	0.6028	−0.1961	0.0826	−0.0699	0.0136	0.1552
8.69	1.8051	0.6465	−0.3550	0.0786	−0.0822	0.0200	0.1734
9.68	2.0778	0.6387	−0.4968	0.0824	−0.1064	0.0303	0.1911
11.72	2.6223	0.6351	−0.5280	0.0904	−0.1345	0.0298	0.1948
15.71	3.8651	0.6321	−0.1340	0.0849	−0.2108	0.0562	0.1999
19.68	5.4482	0.6285	0.2041	0.0784	−0.2769	0.0964	0.2148

(b) $\phi = 22.5°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.28	−0.8299	0.6289	0.4678	0.0760	−0.3569	−0.0531	0.1332
−0.32	−0.0359	0.6094	0.0265	0.0896	−0.0454	−0.0051	0.1235
3.73	0.7499	0.6314	−0.3835	0.0732	0.2607	0.0450	0.1330
7.78	1.6099	0.6577	−0.7599	0.0417	0.3803	0.1476	0.1554
9.70	2.1069	0.6603	−1.1184	0.0163	0.4416	0.1831	0.1660
11.77	2.6723	0.6631	−1.3932	−0.0458	0.5096	0.2555	0.1775
15.73	3.8153	0.6643	−1.1033	−0.1805	1.1820	0.2039	0.1992
19.77	5.1757	0.6388	−0.2625	−0.3995	2.0102	0.0465	0.2169

(c) $\phi = 45°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.15	−0.7627	0.6238	0.9148	0.0661	−0.5861	−0.0172	0.1310
−0.20	−0.0018	0.6057	0.0225	0.0886	−0.0560	0.0122	0.1261
3.81	0.7534	0.6318	−0.8010	0.0719	0.4497	0.0598	0.1325
7.86	1.6272	0.6609	−1.7696	0.0386	0.6314	0.1555	0.1556
9.82	2.1193	0.6661	−2.2819	0.0362	0.6335	0.2108	0.1733
11.85	2.6425	0.6726	−2.6357	0.0424	0.6921	0.2499	0.1839
15.86	3.8136	0.6881	−2.9333	0.0574	0.8919	0.2608	0.2036
19.79	5.1797	0.6510	−2.6512	−0.1135	1.7205	0.1497	0.2300

Table 2. Concluded

(d) $\phi = 67.5°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.12	−0.7506	0.6322	1.3750	0.0761	−0.4988	0.0237	0.1286
−0.04	0.0217	0.6095	−0.0003	0.0901	−0.0516	0.0248	0.1241
3.98	0.7812	0.6352	−1.2952	0.0777	0.3765	0.0418	0.1360
7.94	1.5987	0.6826	−2.4984	0.0857	0.4669	0.0797	0.1518
9.96	2.0724	0.6844	−3.0991	0.1020	0.3708	0.1252	0.1760
11.93	2.5588	0.6854	−3.5200	0.1477	0.3370	0.1708	0.1875
15.92	3.6619	0.6764	−3.5196	0.1919	0.2400	0.3800	0.2086
19.94	5.0250	0.6613	−2.9984	0.1853	−0.0475	0.6764	0.2333

(e) $\phi = 90°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−3.99	−0.7247	0.6278	1.5136	0.0936	−0.1374	0.0532	0.1266
0.11	0.0458	0.6114	−0.0513	0.0915	−0.0736	0.0417	0.1232
4.07	0.8076	0.6402	−1.5722	0.0949	−0.0207	0.0236	0.1352
8.08	1.6370	0.6826	−2.9469	0.1008	−0.0504	0.0378	0.1685
10.07	2.1009	0.6881	−3.5425	0.1051	−0.0711	0.0385	0.1798
12.09	2.6095	0.6850	−3.9598	0.1079	−0.0282	0.0347	0.1886
16.10	3.7491	0.6730	−3.8890	0.1211	0.0531	0.0524	0.1998
20.08	5.1294	0.6543	−3.4656	0.1371	0.2365	0.0424	0.2148

Table 3. Data for Configuration BC1T1 at $M = 1.60$ and $\delta = 5°$

(a) $\phi = 0°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.26	−0.7176	0.6137	1.0412	0.0823	0.0338	−0.0028	0.1565
−0.24	0.0826	0.6312	0.7632	0.0903	−0.0079	0.0130	0.1575
3.77	0.8630	0.6490	0.6407	0.0856	−0.0655	0.0200	0.1679
7.77	1.6014	0.6755	0.8834	0.0635	−0.0102	0.0228	0.1809
9.71	2.1704	0.6915	0.2533	0.0793	−0.0849	0.0304	0.1995
9.79	2.2037	0.6895	0.2279	0.0812	−0.0971	0.0369	0.2026
11.74	2.7227	0.6950	0.0551	0.0940	−0.1616	0.0463	0.2070
15.75	3.9193	0.6914	0.3200	0.0852	−0.2138	0.0515	0.2138
19.72	5.5040	0.6889	0.5772	0.0622	−0.3105	0.0955	0.2257

(b) $\phi = 45°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.05	−0.6804	0.6226	1.4146	0.0629	−0.0926	0.0700	0.1454
−0.08	0.0840	0.6250	0.5216	0.0879	0.4337	0.1191	0.1472
3.96	0.8519	0.6459	−0.2839	0.0597	0.9664	0.1615	0.1612
7.97	1.7013	0.6759	−1.1640	0.0285	1.0253	0.2982	0.1782
9.93	2.2152	0.6884	−1.8273	0.0139	1.0077	0.3421	0.1929
11.96	2.7418	0.6995	−2.2370	−0.0135	1.0116	0.4192	0.2036
15.91	3.8728	0.7022	−2.5492	0.0160	1.1867	0.4306	0.2362
19.91	5.2285	0.6818	−2.1451	−0.1689	1.8165	0.4018	0.2548

(c) $\phi = 90°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.03	−0.7465	0.6466	1.5282	0.0924	0.5895	0.1445	0.1297
0.00	0.0198	0.6259	−0.0160	0.0906	0.6554	0.1515	0.1300
4.06	0.7929	0.6498	−1.5461	0.0952	0.7000	0.1126	0.1388
8.01	1.6174	0.6961	−2.9416	0.1112	0.6689	0.0847	0.1658
10.07	2.0953	0.7024	−3.5447	0.1213	0.5756	0.1054	0.1775
11.97	2.5656	0.6964	−3.9655	0.1292	0.5743	0.1199	0.1862
15.96	3.6791	0.6824	−3.9447	0.1279	0.5863	0.1958	0.2016
20.03	5.0844	0.6504	−3.5393	0.1355	0.5388	0.3415	0.2271

Table 4. Data for Configuration BC1T1 at $M = 1.60$ and $\delta = -5°$

(a) $\phi = 0°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.28	−0.9293	0.6302	−0.3584	0.0884	0.0802	−0.0222	0.1530
−0.26	−0.1550	0.6109	−0.4856	0.0927	0.0047	0.0001	0.1494
3.73	0.6345	0.5993	−0.7495	0.0860	−0.0730	0.0198	0.1524
7.69	1.4733	0.6303	−0.8893	0.0832	−0.0920	0.0292	0.1666
9.74	2.0110	0.6300	−1.0785	0.0890	−0.1090	0.0375	0.1796
11.73	2.5293	0.6161	−1.0518	0.0945	−0.1395	0.0364	0.1879
15.65	3.7854	0.6119	−0.5363	0.0924	−0.2090	0.0597	0.1969
19.74	5.3896	0.5970	−0.0855	0.0698	−0.3511	0.1009	0.2156

(b) $\phi = 45°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.28	−0.8783	0.6365	0.5405	0.0613	−0.9578	−0.1136	0.1546
−0.25	−0.0950	0.6117	−0.3365	0.0912	−0.4057	−0.0738	0.1489
3.77	0.6648	0.6135	−1.1850	0.0712	0.0741	−0.0119	0.1532
7.69	1.5014	0.6449	−2.1551	0.0374	0.3303	0.0509	0.1729
9.79	2.0167	0.6509	−2.6537	0.0287	0.4244	0.0859	0.1850
11.73	2.4922	0.6492	−2.9380	0.0364	0.4421	0.1212	0.1976
15.74	3.6763	0.6450	−3.2285	0.0874	0.7034	0.0748	0.2272
19.75	5.0615	0.6145	−2.6091	−0.1361	1.3941	0.1013	0.2464

(c) $\phi = 90°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.23	−0.7901	0.6507	1.5995	0.0943	−0.6101	−0.0691	0.1308
−0.28	−0.0276	0.6289	0.0834	0.0931	−0.5932	−0.1032	0.1287
3.72	0.7194	0.6439	−1.4094	0.0941	−0.5281	−0.1043	0.1415
7.70	1.5498	0.6947	−2.8546	0.0943	−0.4740	−0.0690	0.1643
9.78	2.0305	0.7054	−3.4599	0.0874	−0.4753	−0.0733	0.1771
11.71	2.4943	0.7036	−3.9033	0.0817	−0.4848	−0.0711	0.1852
15.68	3.5868	0.6892	−3.9745	0.1010	−0.3385	−0.1106	0.1968
19.75	4.9795	0.6600	−3.4997	0.1380	0.0099	−0.2284	0.2217

Table 5. Data for Configuration BC1T1 at $M = 1.60$ and $\delta = 10^\circ$

(a) $\phi = 0^\circ$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.33	−0.6468	0.6285	1.7230	0.0855	0.0669	−0.0048	0.1601
−0.31	0.2002	0.6538	1.3834	0.0910	−0.0024	0.0081	0.1576
3.74	0.9962	0.6858	1.2120	0.0932	−0.1124	0.0378	0.1588
7.75	1.6541	0.7115	1.5939	0.0525	−0.0020	0.0146	0.1662
11.71	2.8036	0.7453	0.3610	0.0907	−0.2199	0.0626	0.1917
15.70	3.9198	0.7366	0.4432	0.0902	−0.2092	0.0556	0.2018
19.75	5.5245	0.7289	0.7247	0.0795	−0.3767	0.1176	0.2187

(b) $\phi = 45^\circ$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.28	−0.6825	0.6299	2.0084	0.0471	0.2546	0.1621	0.1553
−0.25	0.1380	0.6432	1.0156	0.0885	0.8435	0.2104	0.1555
3.73	0.8891	0.6667	0.2665	0.0577	1.3225	0.2734	0.1602
7.72	1.6895	0.7107	−0.5770	0.0114	1.3556	0.3769	0.1688
11.73	2.7208	0.7354	−1.8308	−0.0810	1.1400	0.5773	0.1971
15.70	3.8666	0.7392	−2.2929	−0.0294	1.3574	0.5634	0.2315
19.77	5.1643	0.7176	−1.9257	−0.2227	1.5392	0.6457	0.2524

(c) $\phi = 90^\circ$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.29	−0.7990	0.6785	1.6397	0.1016	1.1767	0.2848	0.1420
−0.32	−0.0311	0.6631	0.0897	0.0904	1.2456	0.2953	0.1385
3.71	0.7285	0.6746	−1.4185	0.0788	1.2429	0.2794	0.1444
7.76	1.5697	0.7197	−2.9032	0.1100	1.1634	0.2105	0.1674
11.71	2.5156	0.7333	−3.9380	0.1438	0.9554	0.2700	0.1851
15.71	3.6104	0.7145	−3.9451	0.1336	0.9964	0.3679	0.2051
19.74	5.0537	0.6913	−3.6596	0.1412	0.8294	0.6587	0.2188

Table 6. Data for Configuration BC1T1 at $M = 1.60$ and $\delta = -10°$

(a) $\phi = 0°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.30	−1.0530	0.6893	−0.9658	0.0916	0.0797	−0.0129	0.1534
−0.29	−0.2590	0.6591	−1.1193	0.0944	−0.0065	0.0041	0.1543
3.72	0.5592	0.6358	−1.4276	0.0891	−0.1395	0.0391	0.1625
7.75	1.4089	0.6301	−1.6025	0.0899	−0.1324	0.0483	0.1731
11.73	2.4378	0.6067	−1.6798	0.0868	−0.0957	0.0304	0.1900
15.76	3.7247	0.5979	−1.1260	0.0897	−0.2424	0.0784	0.2028
19.76	5.3047	0.5745	−0.5115	0.0761	−0.3315	0.1301	0.2190

(b) $\phi = 45°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.28	−0.9696	0.6736	0.0719	0.0534	−1.3759	−0.2144	0.1574
−0.28	−0.1920	0.6425	−0.7742	0.0902	−0.8720	−0.1661	0.1578
3.73	0.6025	0.6298	−1.6754	0.0564	−0.3184	−0.1092	0.1626
7.69	1.4479	0.6563	−2.6268	0.0118	−0.0364	−0.0183	0.1773
11.68	2.4023	0.6414	−3.3172	−0.0072	0.1115	0.0546	0.2098
15.71	3.5768	0.6194	−3.4788	0.0164	0.4889	0.0477	0.2434
19.74	5.0627	0.5932	−2.9595	−0.0944	1.1610	0.0333	0.2569

(c) $\phi = 90°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.26	−0.7923	0.6742	1.6350	0.0831	−1.2149	−0.2069	0.1374
−0.31	−0.0352	0.6606	0.1175	0.0954	−1.2331	−0.2313	0.1375
3.76	0.7485	0.6788	−1.4637	0.1000	−1.1611	−0.2078	0.1412
7.68	1.5647	0.7133	−2.8811	0.0883	−1.0612	−0.1781	0.1683
11.77	2.5294	0.7230	−3.8989	0.0666	−0.9432	−0.1942	0.1960
15.72	3.6238	0.7087	−3.9151	0.1016	−0.7716	−0.2865	0.2070
19.76	5.0323	0.6913	−3.6024	0.1433	−0.3251	−0.5161	0.2205

Table 7. Data for Configuration BC1T1 at $M = 1.60$ and $\delta = 15°$

(a) $\phi = 0°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.28	−0.5919	0.6481	2.5531	0.0890	0.0880	−0.0067	0.1673
−0.34	0.2776	0.6824	1.9997	0.0903	0.0062	0.0111	0.1640
3.75	1.0985	0.7223	1.6501	0.0931	−0.1128	0.0421	0.1654
7.77	1.7278	0.7552	2.0238	0.0439	−0.0037	0.0325	0.1708
9.75	2.3188	0.7624	1.1604	0.0703	−0.0641	0.0393	0.1924
11.71	2.8355	0.7808	0.7166	0.0895	−0.1752	0.0603	0.1980
15.73	3.9637	0.7781	0.5425	0.0832	−0.1713	0.0664	0.2055
19.78	5.5995	0.7753	0.9682	0.0791	−0.2492	0.0693	0.2294

(b) $\phi = 22.5°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.31	−0.6108	0.6810	2.6236	0.0297	0.2277	0.1438	0.1358
−0.23	0.2736	0.7120	1.8591	0.0912	0.6493	0.1805	0.1344
3.67	1.0471	0.7477	1.4132	0.0696	0.8886	0.2352	0.1364
7.66	1.7691	0.7846	1.1995	0.0771	0.7509	0.3450	0.1558
9.68	2.3366	0.7927	0.3847	−0.0036	0.9034	0.3504	0.1684
11.69	2.8619	0.8027	−0.0651	−0.0829	0.9381	0.4085	0.1753
15.71	3.8968	0.7978	−0.1499	−0.3518	1.2507	0.5458	0.1947
19.69	5.2715	0.7931	0.4922	−0.4501	1.4018	0.6225	0.2083

(c) $\phi = 45°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.27	−0.6432	0.6752	2.5870	0.0350	0.6277	0.2585	0.1551
−0.30	0.1972	0.6913	1.4679	0.0909	1.2705	0.2959	0.1539
3.78	0.9728	0.7251	0.6239	0.0459	1.6835	0.3676	0.1572
7.74	1.7388	0.7696	−0.1837	0.0010	1.6160	0.4800	0.1687
9.68	2.2363	0.7743	−0.9576	−0.0541	1.5215	0.5656	0.1802
11.71	2.7691	0.7875	−1.5558	−0.1021	1.3142	0.7069	0.1986
15.77	3.9124	0.8050	−2.0681	−0.1151	1.3037	0.7896	0.2167
19.72	5.1838	0.7797	−1.7766	−0.2186	1.1812	0.8339	0.2432

Table 7. Concluded

(d) $\phi = 67.5°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.28	−0.7122	0.7133	2.3139	0.0742	1.2317	0.3528	0.1408
−0.26	0.1094	0.7128	0.8269	0.0913	1.7165	0.3925	0.1341
3.74	0.8369	0.7445	−0.4388	0.0415	2.0046	0.4213	0.1379
7.76	1.6569	0.7809	−1.7722	0.0389	1.8271	0.4687	0.1547
9.67	2.0754	0.7760	−2.2795	0.0904	1.7248	0.4907	0.1686
11.72	2.6208	0.7996	−2.9937	0.1465	1.4118	0.5625	0.1817
15.68	3.6579	0.7908	−3.2812	0.1509	1.0894	0.8824	0.2154
19.72	5.0202	0.7549	−2.9260	0.1774	0.1083	1.4948	0.2392

(e) $\phi = 90°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.24	−0.7965	0.7321	1.6121	0.1189	1.7275	0.4112	0.1411
−0.30	−0.0396	0.7078	0.0866	0.0915	1.8705	0.4150	0.1372
3.66	0.7232	0.7224	−1.4343	0.0634	1.7457	0.4020	0.1434
7.75	1.5662	0.7637	−2.9045	0.0911	1.6973	0.3497	0.1611
9.71	2.0483	0.7779	−3.6137	0.1324	1.3515	0.3875	0.1757
11.69	2.5311	0.7792	−4.0048	0.1572	1.3365	0.4181	0.1827
15.73	3.6166	0.7669	−3.9872	0.1269	1.2150	0.6381	0.1985
19.78	5.1706	0.7355	−3.8783	0.1583	1.1779	0.9531	0.2265

Table 8. Data for Configuration BC1T1 at $M = 1.60$ and $\delta = -15°$

(a) $\phi = 0°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.28	−1.1708	0.7301	−1.4302	0.0925	0.0884	−0.0260	0.1478
−0.30	−0.3638	0.6928	−1.7852	0.0956	−0.0692	0.0211	0.1532
3.72	0.5040	0.6611	−2.3050	0.0971	−0.1730	0.0433	0.1582
7.74	1.2968	0.6493	−2.1944	0.0926	−0.1533	0.0443	0.1668
9.73	1.7867	0.6290	−2.2363	0.0966	−0.1674	0.0549	0.1760
11.75	2.3252	0.6165	−2.2106	0.0917	−0.1268	0.0355	0.1837
15.74	3.5806	0.5966	−1.7549	0.0911	−0.2329	0.0625	0.1941
19.65	5.0953	0.5659	−1.0508	0.0840	−0.3388	0.1118	0.2141

(b) $\phi = 22.5°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.24	−1.1165	0.7435	−1.1575	0.0680	−0.9327	−0.1959	0.1310
−0.24	−0.3280	0.7089	−1.6313	0.0955	−0.7664	−0.1158	0.1367
3.66	0.5080	0.6779	−2.3139	0.0431	−0.3727	−0.0844	0.1455
7.77	1.3573	0.6784	−2.5977	0.0139	−0.0317	−0.0318	0.1561
9.69	1.8291	0.6656	−2.7418	−0.0150	0.0785	−0.0009	0.1665
11.69	2.3387	0.6545	−2.7886	−0.0581	0.2348	0.0168	0.1756
15.72	3.5088	0.6205	−2.4918	−0.1293	0.9668	−0.0742	0.2081
19.68	4.9454	0.5841	−1.6323	−0.2787	1.9727	−0.3765	0.2166

(c) $\phi = 45°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.35	−1.0392	0.7226	−0.3352	0.0419	−1.7246	−0.3045	0.1540
−0.27	−0.2424	0.6905	−1.2427	0.0954	−1.3299	−0.2347	0.1540
3.72	0.5626	0.6727	−2.2667	0.0451	−0.7167	−0.1860	0.1572
7.76	1.4003	0.6918	−3.0600	−0.0059	−0.4168	−0.0592	0.1708
9.73	1.8800	0.6786	−3.3947	−0.0397	−0.3014	−0.0015	0.1912
11.69	2.3685	0.6658	−3.6443	−0.0569	−0.2766	0.0604	0.2070
15.67	3.5032	0.6440	−3.6473	−0.0225	0.0100	0.1054	0.2228
19.69	4.9388	0.6209	−3.0494	−0.1159	0.7419	−0.0151	0.2368

Table 8. Concluded

(d) $\phi = 67.5^\circ$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.31	−0.9120	0.7408	0.7054	0.0429	−1.9949	−0.3624	0.1368
−0.31	−0.1599	0.7091	−0.6012	0.0968	−1.7452	−0.3137	0.1362
3.76	0.6503	0.7063	−2.0559	0.0758	−1.2371	−0.2730	0.1432
7.72	1.4811	0.7411	−3.2590	0.0472	−0.8982	−0.1807	0.1544
9.70	1.9397	0.7460	−3.7604	0.0171	−0.7980	−0.1045	0.1664
11.72	2.4201	0.7375	−4.0774	0.0161	−0.8333	−0.0418	0.1789
15.67	3.4892	0.7152	−3.9137	0.1450	−0.8944	0.0310	0.2030
19.68	4.8512	0.6965	−3.4305	0.1986	−0.5642	−0.0732	0.2235

(e) $\phi = 90^\circ$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.31	−0.8065	0.7214	1.6648	0.0725	−1.7581	−0.3358	0.1387
−0.28	−0.0295	0.7078	0.1191	0.0972	−1.8668	−0.3418	0.1358
3.68	0.7371	0.7308	−1.4200	0.1214	−1.6861	−0.3535	0.1417
7.68	1.5749	0.7596	−2.9024	0.1144	−1.5359	−0.3042	0.1667
9.73	2.0724	0.7738	−3.5759	0.0799	−1.2761	−0.3289	0.1810
11.68	2.5226	0.7695	−3.9069	0.0627	−1.2790	−0.3429	0.1920
15.74	3.6491	0.7585	−3.9920	0.1183	−0.9826	−0.5414	0.2009
19.76	5.1591	0.7442	−3.8414	0.1291	−0.6549	−0.8165	0.2161

Table 9. Data for Configuration BC1 at $M = 1.60$ and $\delta = 0°$

(a) $\phi = 0°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.33	−0.4188	0.4625	−1.5332	−0.0007	−0.0081	0.0030	0.1325
−0.33	−0.0321	0.4414	0.0084	−0.0025	0.0137	0.0048	0.1218
3.72	0.3535	0.4696	1.5574	−0.0041	0.0275	0.0050	0.1380
7.69	0.8272	0.4862	3.0781	−0.0063	0.0536	0.0081	0.1822
9.77	1.1405	0.4826	3.8111	−0.0066	0.0443	0.0088	0.2167
11.74	1.5001	0.4879	4.5862	−0.0071	0.1138	−0.0012	0.2305
15.68	2.4289	0.4979	6.5136	−0.0083	0.0819	0.0126	0.2414
19.72	3.6217	0.4963	8.5793	−0.0067	0.0940	0.0481	0.2593

(b) $\phi = 45°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.32	−0.3186	0.4708	−1.2159	−0.0013	−0.4144	−0.0815	0.1330
−0.34	−0.0111	0.4376	−0.0201	−0.0022	−0.0088	−0.0116	0.1233
3.75	0.2916	0.4594	1.1746	−0.0028	0.3913	0.0585	0.1463
7.69	0.6825	0.4880	2.3003	−0.0016	0.8461	0.0958	0.1792
9.73	0.9470	0.4978	2.8142	−0.0016	1.1807	0.0641	0.1963
11.75	1.2651	0.5059	3.3916	0.0010	1.5560	0.0264	0.2129
15.74	2.0822	0.5201	4.6641	0.0037	2.3593	−0.1119	0.2323
19.75	3.1968	0.5051	6.2833	−0.0001	2.1015	0.0392	0.2525

(c) $\phi = 90°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.28	−0.2368	0.4598	−0.8118	−0.0060	−0.0087	0.0032	0.1275
−0.31	−0.0134	0.4345	0.0061	−0.0042	−0.0030	0.0001	0.1225
3.76	0.2188	0.4522	0.8588	−0.0022	0.0287	0.0077	0.1481
7.74	0.5536	0.5097	1.5914	−0.0018	0.0077	0.0054	0.1685
9.71	0.7840	0.5025	2.0253	−0.0011	0.0159	0.0116	0.1949
11.71	1.0438	0.5052	2.5282	0.0004	0.0059	0.0157	0.2093
15.73	1.8202	0.5179	4.1018	0.0021	−0.0043	0.0474	0.2382
19.73	2.9780	0.5292	5.3133	0.0060	0.0213	0.0711	0.2573

Table 10. Data for Configuration BC2 at $M = 1.60$ and $\delta = 0°$

(a) $\phi = 0°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.25	−0.3857	0.4484	−1.4689	−0.0038	0.0008	0.0104	0.1315
−0.32	−0.0187	0.4199	0.0191	−0.0053	0.0171	0.0047	0.1254
3.75	0.3637	0.4480	1.5615	−0.0079	0.0445	0.0040	0.1449
7.68	0.8201	0.4730	2.9969	−0.0081	0.0543	0.0054	0.1810
9.69	1.1281	0.4700	3.7057	−0.0075	0.0631	0.0092	0.2163
11.68	1.4666	0.4746	4.4226	−0.0076	0.0661	0.0080	0.2313
15.70	2.3854	0.4871	6.3376	−0.0084	0.1170	0.0094	0.2392
19.68	3.5826	0.4733	8.3573	−0.0092	0.1281	0.0199	0.2661

(b) $\phi = 45°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.34	−0.3146	0.4524	−1.1719	−0.0056	−0.3630	−0.0516	0.1356
−0.34	−0.0158	0.4193	−0.0051	−0.0066	0.0103	0.0059	0.1243
3.76	0.2913	0.4486	1.2097	−0.0069	0.4191	0.0742	0.1454
7.67	0.6708	0.4807	2.2957	−0.0053	0.8585	0.1053	0.1721
9.69	0.9265	0.4857	2.8162	−0.0040	1.1613	0.0745	0.1943
11.74	1.2499	0.5006	3.3829	−0.0016	1.5488	0.0246	0.2084
15.75	2.0554	0.5062	4.6330	−0.0015	2.2940	−0.1293	0.2343
19.79	3.1824	0.4845	6.3552	−0.0067	1.8563	0.0936	0.2564

(c) $\phi = 90°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.31	−0.2480	0.4528	−0.8063	−0.0073	0.0119	0.0082	0.1304
−0.29	−0.0153	0.4234	0.0092	−0.0060	0.0309	0.0132	0.1179
3.77	0.2178	0.4404	0.8418	−0.0054	0.0839	0.0185	0.1522
7.68	0.5409	0.4904	1.6048	−0.0039	0.1013	0.0194	0.1734
9.73	0.7788	0.4906	2.0333	−0.0035	0.0518	0.0235	0.1939
11.73	1.0453	0.4984	2.5507	−0.0024	0.0219	0.0352	0.2037
15.74	1.8245	0.5138	4.0971	−0.0007	0.0784	0.0498	0.2295
19.78	3.0249	0.5099	5.3962	0.0024	0.0150	0.1102	0.2653

Table 11. Data for Configuration BT1 at $M = 1.60$

(a) $\phi = 0°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.33	−0.7011	0.5569	1.2382	0.0860	0.0285	0.0047	0.1582
−0.25	−0.0285	0.5482	0.1453	0.0923	−0.0072	0.0159	0.1525
3.71	0.6138	0.5603	−0.9061	0.0889	−0.0979	0.0384	0.1610
7.70	1.3499	0.5849	−1.9200	0.0901	−0.1190	0.0455	0.1807
9.75	1.7859	0.5931	−2.3654	0.0946	−0.1405	0.0469	0.1887
11.73	2.2545	0.5941	−2.7408	0.0963	−0.1464	0.0383	0.1970
15.72	3.4262	0.6088	−2.9498	0.0969	−0.2584	0.0537	0.2040
19.68	4.7241	0.5988	−2.3843	0.0867	−0.3835	0.1054	0.2304

(b) $\phi = 45°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.25	−0.7372	0.5689	1.4147	0.0658	−0.1411	0.0337	0.1544
−0.26	−0.0289	0.5481	0.0910	0.0921	−0.0259	0.0150	0.1483
3.71	0.6700	0.5727	−1.1772	0.0733	0.0877	−0.0129	0.1566
7.77	1.4963	0.6250	−2.5851	0.0279	0.0405	−0.0055	0.1714
9.74	1.9363	0.6170	−3.1354	−0.0082	−0.0039	0.0168	0.1974
11.72	2.3957	0.6223	−3.4859	−0.0415	−0.1182	0.0560	0.2087
15.72	3.5222	0.6150	−3.5386	−0.0712	−0.2996	0.1045	0.2295
19.70	4.8588	0.6148	−3.0373	−0.1608	−0.2096	0.1143	0.2485

(c) $\phi = 90°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.31	−0.8058	0.5857	1.6562	0.0996	−0.0869	0.0274	0.1519
−0.28	−0.0367	0.5471	0.1046	0.0945	−0.0488	0.0231	0.1478
3.74	0.7361	0.5834	−1.4410	0.0984	0.0085	0.0124	0.1569
7.76	1.5516	0.6350	−2.8237	0.1087	0.0078	0.0099	0.1834
9.73	2.0184	0.6402	−3.4269	0.1070	−0.0283	0.0209	0.1964
11.73	2.5062	0.6334	−3.8570	0.1056	−0.0415	0.0298	0.2052
15.69	3.6356	0.6160	−3.8713	0.1225	0.0301	0.0465	0.2227
19.69	4.9928	0.5962	−3.4059	0.1335	0.2015	0.0351	0.2388

Table 12. Data for Configuration BT2 at $M = 1.60$

(a) $\phi = 0°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.23	−0.7116	0.6464	1.2312	−0.0137	−0.0836	0.0214	0.1633
−2.25	−0.3790	0.6509	0.7074	−0.0132	−0.0648	0.0152	0.1501
−0.17	−0.0346	0.6509	0.0843	−0.0139	−0.0086	0.0025	0.1440
1.80	0.3053	0.6495	−0.5258	−0.0143	0.0429	−0.0081	0.1476
3.81	0.6410	0.6462	−1.0693	−0.0148	0.0644	−0.0126	0.1604
5.80	0.9978	0.6488	−1.5962	−0.0124	0.0371	−0.0038	0.1655
7.83	1.4002	0.6491	−2.1561	−0.0157	0.0483	−0.0017	0.1800
9.79	1.8229	0.6477	−2.6182	−0.0222	0.0921	−0.0174	0.1892
11.79	2.3129	0.6467	−3.0062	−0.0178	0.0975	−0.0094	0.1992
13.81	2.8587	0.6517	−3.2421	−0.0161	0.1607	−0.0268	0.2101
16.77	3.8017	0.6560	−3.0967	−0.0128	0.2432	−0.0450	0.2256
19.81	4.9009	0.6393	−2.8218	0.0018	0.2646	−0.0397	0.2351

(b) $\phi = 45°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.20	−0.7907	0.6537	1.5845	−0.0401	−0.0851	0.0132	0.1690
−2.20	−0.4051	0.6472	0.8174	−0.0209	−0.0789	0.0158	0.1481
−0.22	−0.0425	0.6445	0.0881	−0.0143	−0.0256	−0.0042	0.1428
1.81	0.3392	0.6451	−0.6681	−0.0233	−0.0278	0.0088	0.1484
3.78	0.7168	0.6504	−1.4109	−0.0447	−0.0491	0.0177	0.1666
5.82	1.1265	0.6658	−2.1624	−0.0689	−0.0665	0.0181	0.1876
7.80	1.5419	0.6703	−2.8284	−0.1040	−0.1666	0.0504	0.2022
9.78	1.9959	0.6727	−3.4178	−0.1387	−0.2514	0.0826	0.2173
11.79	2.4832	0.6630	−3.8588	−0.1610	−0.4899	0.1490	0.2410
13.78	3.0163	0.6506	−4.0856	−0.1746	−0.7218	0.2130	0.2604
16.82	4.0444	0.6369	−4.0781	−0.2054	−0.8717	0.2636	0.2835
19.77	5.0861	0.6184	−3.8754	−0.2585	−0.8977	0.2867	0.2977

(c) $\phi = 90°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.19	−0.7870	0.6603	1.5594	−0.0105	0.0840	−0.0273	0.1663
−2.20	−0.4096	0.6471	0.8415	−0.0150	0.0169	−0.0022	0.1478
−0.18	−0.0465	0.6412	0.1264	−0.0160	−0.0541	0.0087	0.1449
1.83	0.3230	0.6444	−0.5953	−0.0170	−0.1336	0.0299	0.1485
3.82	0.6942	0.6573	−1.2976	−0.0171	−0.1982	0.0446	0.1667
5.78	1.0630	0.6769	−1.9123	−0.0192	−0.2846	0.0763	0.1864
7.78	1.4711	0.6847	−2.4975	−0.0217	−0.3256	0.0799	0.2018
9.79	1.9193	0.6815	−3.0315	−0.0326	−0.3931	0.1026	0.2122
11.80	2.3996	0.6722	−3.4190	−0.0397	−0.4297	0.1199	0.2194
13.81	2.9591	0.6577	−3.6781	−0.0505	−0.4640	0.1510	0.2300
16.82	3.9439	0.6387	−3.6579	−0.0625	−0.4576	0.1591	0.2398
19.82	5.0044	0.6203	−3.2651	−0.0608	−0.4050	0.1560	0.2606

Table 13. Data for Configuration B at $M = 1.60$

(a) $\phi = 0°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.32	−0.2259	0.4246	−0.8834	0.0011	0.0003	0.0025	0.1323
−0.33	−0.0125	0.4002	0.0083	0.0003	0.0186	0.0034	0.1208
3.69	0.1995	0.4189	0.9237	−0.0009	0.0338	0.0061	0.1447
7.67	0.5257	0.4674	1.7034	−0.0019	0.0462	0.0067	0.1843
9.71	0.7499	0.4615	2.1449	−0.0028	0.0718	0.0062	0.2224
11.76	1.0199	0.4698	2.6954	−0.0032	0.0632	−0.0001	0.2332
15.68	1.7910	0.4796	4.2750	−0.0045	0.1239	−0.0127	0.2489
19.67	2.8468	0.4796	6.0117	−0.0061	0.0388	0.0140	0.2723

(b) $\phi = 45°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.34	−0.2369	0.4226	−0.8997	0.0005	0.0280	0.0067	0.1431
−0.22	−0.0056	0.4005	0.0361	−0.0018	0.0288	0.0103	0.1194
3.71	0.1992	0.4201	0.9000	0.0001	0.0234	0.0113	0.1450
7.74	0.5281	0.4542	1.7211	0.0038	0.0113	0.0267	0.1727
9.68	0.7496	0.4523	2.1258	0.0056	0.0062	0.0243	0.1917
11.68	1.0161	0.4496	2.6672	0.0081	−0.0383	0.0292	0.2101
15.66	1.7932	0.4502	4.1943	0.0123	0.0235	0.0169	0.2402
19.66	2.9082	0.4623	5.7854	0.0163	0.2188	0.0134	0.2540

(c) $\phi = 90°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.31	−0.2399	0.4152	−0.8971	−0.0032	−0.0050	0.0026	0.1345
−0.28	−0.0136	0.3973	0.0073	−0.0024	0.0186	0.0060	0.1163
3.75	0.2045	0.4156	0.9024	−0.0017	0.0292	0.0092	0.1455
7.76	0.5272	0.4455	1.7372	−0.0011	0.0460	0.0159	0.1792
9.68	0.7454	0.4498	2.1454	−0.0001	0.0395	0.0210	0.1958
11.67	1.0217	0.4544	2.6493	0.0008	0.0115	0.0249	0.2121
15.68	1.8183	0.4723	4.1344	0.0031	0.0539	0.0485	0.2428
19.77	3.0239	0.4984	5.4350	0.0075	0.0155	0.0641	0.2643

Table 14. Data for Configuration BC1T1 at $M = 1.90$ and $\delta = 0°$

(a) $\phi = 0°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.33	−0.7342	0.5659	−0.0001	0.0835	0.0225	−0.0051	0.1495
−0.30	−0.0443	0.5498	0.1077	0.0881	0.0324	−0.0096	0.1429
3.71	0.6278	0.5654	0.2650	0.0837	0.0133	−0.0072	0.1429
7.66	1.3448	0.6057	0.5521	0.0825	0.0046	0.0031	0.1505
9.72	1.8621	0.6077	0.4942	0.0958	−0.0518	0.0200	0.1575
11.68	2.3764	0.6046	0.7899	0.0945	−0.1283	0.0450	0.1622
15.62	3.6670	0.6117	1.5394	0.0888	−0.0895	0.0268	0.1712
19.71	5.1968	0.6074	1.8095	0.0872	−0.0645	0.0135	0.1855

(b) $\phi = 45°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.18	−0.7025	0.5940	0.6993	0.0703	−0.6365	0.0262	0.1307
−0.19	−0.0151	0.5672	0.1348	0.0879	−0.0307	0.0256	0.1253
3.80	0.6528	0.5987	−0.3826	0.0745	0.5386	0.0373	0.1247
7.76	1.4202	0.6358	−0.9054	0.0449	0.8813	0.0793	0.1379
9.83	1.8997	0.6456	−1.1934	0.0441	0.9761	0.1147	0.1531
11.85	2.4410	0.6577	−1.3469	0.0499	1.0078	0.1583	0.1636
15.79	3.7285	0.6703	−1.4658	0.0818	1.2148	0.1108	0.1736
19.81	5.1213	0.6668	−1.1723	−0.0980	1.8178	0.0783	0.1852

(c) $\phi = 90°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−3.97	−0.6960	0.5963	1.3050	0.0941	−0.0658	0.0468	0.1316
0.02	−0.0115	0.5738	0.1305	0.0901	−0.0521	0.0402	0.1208
4.04	0.6801	0.6101	−1.0351	0.0927	−0.0312	0.0372	0.1253
8.08	1.4869	0.6449	−2.0886	0.1025	−0.0135	0.0314	0.1513
10.02	1.9194	0.6588	−2.4372	0.1057	0.0345	0.0384	0.1557
12.03	2.4248	0.6597	−2.5564	0.1052	0.0248	0.0319	0.1624
15.97	3.6175	0.6560	−2.2826	0.0981	0.0596	0.0432	0.1714
19.99	5.0735	0.6574	−2.2711	0.0977	0.0769	0.0558	0.1828

Table 15. Data for Configuration BC1T1 at $M = 1.90$ and $\delta = 5°$

(a) $\phi = 0°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
0.02	0.0993	0.5837	0.6927	0.0922	0.0154	0.0103	0.1478
−4.32	−0.6434	0.5724	0.6271	0.0865	0.0473	−0.0036	0.1509
−0.26	0.0397	0.5829	0.6830	0.0912	0.0202	0.0078	0.1496
3.66	0.6987	0.6047	0.8828	0.0880	−0.0132	0.0144	0.1486
7.77	1.4102	0.6444	1.3272	0.0797	0.0243	0.0053	0.1562
9.67	1.9071	0.6546	1.1326	0.0978	−0.0416	0.0257	0.1641
11.69	2.4313	0.6552	1.3501	0.1041	−0.1513	0.0402	0.1686
15.70	3.7443	0.6621	2.0095	0.1062	−0.1072	0.0119	0.1773
19.66	5.2106	0.6694	2.2637	0.1014	−0.0757	0.0240	0.1851

(b) $\phi = 45°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.12	−0.6574	0.5688	1.1311	0.0692	−0.2329	0.0921	0.1437
−0.09	0.0433	0.5561	0.5408	0.0920	0.3621	0.1066	0.1413
3.91	0.7179	0.5890	0.0550	0.0695	0.9544	0.1233	0.1419
7.87	1.4723	0.6306	−0.4171	0.0384	1.2069	0.1884	0.1506
9.94	1.9757	0.6493	−0.7715	0.0267	1.2727	0.2352	0.1616
11.91	2.4895	0.6683	−0.9438	−0.0065	1.2991	0.3156	0.1680
15.90	3.7622	0.6807	−1.0082	0.0347	1.3811	0.3197	0.1810
19.92	5.1725	0.6794	−0.9106	−0.1251	2.0423	0.1970	0.1946

(c) $\phi = 90°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.09	−0.7221	0.6091	1.3243	0.0959	0.5307	0.1052	0.1330
0.01	−0.0243	0.5835	0.1449	0.0914	0.5332	0.1244	0.1255
4.00	0.6712	0.6150	−1.0165	0.0944	0.5827	0.0907	0.1272
8.03	1.4741	0.6639	−2.1242	0.1103	0.5873	0.0593	0.1422
10.04	1.9226	0.6690	−2.4505	0.1155	0.6112	0.0638	0.1538
11.93	2.3991	0.6675	−2.5551	0.1093	0.5817	0.0931	0.1626
15.96	3.6131	0.6661	−2.2914	0.1003	0.4770	0.1794	0.1678
20.00	5.0812	0.6663	−2.3122	0.0944	0.4675	0.2583	0.1829

Table 16. Data for Configuration BC1T1 at $M = 1.90$ and $\delta = -5°$

(a) $\phi = 0°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.37	−0.8523	0.5836	−0.4449	0.0876	0.0346	−0.0003	0.1447
−0.33	−0.1722	0.5629	−0.2951	0.0927	0.0311	0.0049	0.1410
3.68	0.4968	0.5559	−0.1669	0.0890	−0.0127	0.0122	0.1401
7.66	1.2467	0.5842	0.0111	0.0925	−0.0191	0.0199	0.1532
9.65	1.7289	0.5823	0.0390	0.0981	−0.0538	0.0239	0.1593
11.69	2.2569	0.5759	0.2722	0.1028	−0.0877	0.0337	0.1635
15.70	3.6163	0.5739	1.1404	0.0955	−0.0854	0.0324	0.1800
19.71	5.1001	0.5775	1.4475	0.0862	−0.0387	0.0159	0.1839

(b) $\phi = 45°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.36	−0.8303	0.5957	0.4292	0.0660	−0.9411	−0.0549	0.1452
−0.29	−0.1290	0.5625	−0.1365	0.0922	−0.3112	−0.0599	0.1415
3.71	0.5501	0.5717	−0.6691	0.0763	0.2413	−0.0400	0.1438
7.63	1.3103	0.6097	−1.2233	0.0448	0.6368	−0.0090	0.1530
9.64	1.7638	0.6191	−1.4471	0.0387	0.7771	0.0199	0.1642
11.71	2.3011	0.6169	−1.5839	0.0399	0.8275	0.0547	0.1848
15.64	3.5553	0.6226	−1.5029	0.0622	0.9440	0.0255	0.1921
19.68	5.0296	0.6252	−1.4114	−0.0651	1.5922	−0.0138	0.2001

(c) $\phi = 90°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.38	−0.7696	0.6169	1.3984	0.0972	−0.4721	−0.0659	0.1298
−0.28	−0.0689	0.5874	0.2141	0.0927	−0.4461	−0.0913	0.1235
3.66	0.6077	0.6192	−0.9275	0.0933	−0.4257	−0.0775	0.1262
7.66	1.3942	0.6608	−2.0155	0.0954	−0.3887	−0.0497	0.1443
9.74	1.8555	0.6696	−2.4194	0.0963	−0.3666	−0.0515	0.1534
11.70	2.3480	0.6699	−2.5730	0.1001	−0.3152	−0.0649	0.1603
15.69	3.5269	0.6612	−2.2814	0.1033	−0.1923	−0.1101	0.1713
19.69	4.9657	0.6647	−2.2443	0.1154	−0.0565	−0.1943	0.1828

Table 17. Data for Configuration BC1T1 at $M = 1.90$ and $\delta = 10°$

(a) $\phi = 0°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−0.60	0.1204	0.5967	1.1339	0.0899	0.0179	0.0059	0.1479
−0.32	0.1341	0.5975	1.1318	0.0891	0.0367	−0.0055	0.1446
3.66	0.8292	0.6267	1.3329	0.0908	−0.0265	0.0100	0.1447
7.69	1.4440	0.6575	1.9437	0.0613	0.0559	−0.0031	0.1508
11.70	2.4953	0.6881	1.6036	0.1020	−0.1289	0.0325	0.1617
15.65	3.7252	0.6884	2.2678	0.1047	−0.1420	0.0259	0.1731
19.71	5.2890	0.7011	2.4521	0.0967	−0.1182	0.0221	0.1788

(b) $\phi = 45°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.34	−0.6462	0.5945	1.5393	0.0570	0.0367	0.1528	0.1490
−0.28	0.0861	0.5949	0.8900	0.0905	0.6512	0.1821	0.1468
3.66	0.7549	0.6234	0.4258	0.0671	1.2426	0.1906	0.1471
7.73	1.5087	0.6664	−0.0048	0.0317	1.4332	0.2707	0.1589
11.67	2.4899	0.7078	−0.6259	−0.0378	1.4764	0.4255	0.1723
15.64	3.7069	0.7214	−0.6944	−0.0176	1.4873	0.4708	0.1885
19.68	5.1107	0.7196	−0.6927	−0.1412	1.9277	0.3707	0.2004

(c) $\phi = 90°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.37	−0.7661	0.6391	1.4033	0.1035	0.9726	0.2259	0.1364
−0.38	−0.0868	0.6163	0.2519	0.0905	0.9689	0.2648	0.1311
3.73	0.6165	0.6356	−0.9319	0.0832	1.0156	0.2280	0.1333
7.70	1.4092	0.6829	−2.0880	0.1080	0.9768	0.1584	0.1456
11.74	2.3635	0.7025	−2.6394	0.1159	0.9119	0.2081	0.1588
15.71	3.5364	0.6903	−2.3201	0.0848	0.7307	0.3799	0.1726
19.71	5.0097	0.6900	−2.4443	0.0825	0.7038	0.4942	0.1888

Table 18. Data for Configuration BC1T1 at $M = 1.90$ and $\delta = -10°$

(a) $\phi = 0°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.32	−0.9488	0.6181	−0.9694	0.0892	0.0695	−0.0139	0.1489
−0.29	−0.2656	0.5909	−0.7772	0.0921	0.0411	−0.0110	0.1461
3.73	0.4319	0.5771	−0.7172	0.0960	−0.0696	0.0190	0.1458
5.69	0.7809	0.5704	−0.6117	0.0983	−0.0442	0.0110	0.1471
11.70	2.1710	0.5724	−0.2187	0.1072	−0.1580	0.0408	0.1597
15.69	3.5327	0.5667	0.6031	0.1037	−0.1472	0.0483	0.1718
19.67	5.0020	0.5575	0.9598	0.0932	−0.1707	0.0422	0.1844

(b) $\phi = 45°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.38	−0.9064	0.6348	0.0496	0.0597	−1.2848	−0.1440	0.1462
−0.35	−0.2112	0.5977	−0.4719	0.0906	−0.6745	−0.1380	0.1425
3.72	0.4988	0.5952	−1.0346	0.0704	−0.0707	−0.1097	0.1452
7.66	1.2624	0.6199	−1.5935	0.0273	0.3057	−0.0621	0.1581
11.70	2.2320	0.6306	−1.8706	0.0155	0.4986	−0.0049	0.1766
15.68	3.5131	0.6207	−1.6375	−0.0033	0.6997	0.0167	0.1909
19.70	4.9821	0.6153	−1.5066	−0.0787	1.3429	−0.0934	0.2069

(c) $\phi = 90°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.29	−0.7645	0.6347	1.4103	0.0891	−0.9556	−0.1592	0.1328
−0.35	−0.0882	0.6137	0.2695	0.0921	−0.9438	−0.1985	0.1269
3.72	0.6112	0.6385	−0.9222	0.0984	−0.9321	−0.1773	0.1305
7.67	1.3924	0.6799	−2.0627	0.0922	−0.8810	−0.1288	0.1460
11.71	2.3438	0.6933	−2.6044	0.0948	−0.7348	−0.1562	0.1621
15.67	3.4973	0.6849	−2.3119	0.1176	−0.4768	−0.2986	0.1701
19.70	4.9825	0.6876	−2.4361	0.1223	−0.4248	−0.3936	0.1839

Table 19. Data for Configuration BC1T1 at $M = 1.90$ and $\delta = 15°$

(a) $\phi = 0°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.33	−0.5313	0.6008	1.8126	0.0896	0.0733	0.0014	0.1585
−0.31	0.2411	0.6387	1.6757	0.0907	0.0305	0.0124	0.1518
3.68	0.9361	0.6723	1.7602	0.0902	−0.0424	0.0304	0.1530
7.73	1.5148	0.7039	2.3923	0.0540	0.0699	0.0134	0.1561
9.65	2.0332	0.7284	1.8966	0.0823	0.0035	0.0270	0.1600
11.72	2.5560	0.7388	1.8679	0.0965	−0.0978	0.0489	0.1689
15.71	3.7526	0.7361	2.5341	0.0934	−0.1221	0.0524	0.1814
19.70	5.3034	0.7363	2.6302	0.0909	−0.0462	0.0364	0.1994

(b) $\phi = 45°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.27	−0.5930	0.6330	1.9843	0.0506	0.3244	0.2503	0.1517
−0.25	0.1591	0.6502	1.2828	0.0911	1.0273	0.2732	0.1397
3.65	0.8136	0.6776	0.8159	0.0623	1.5529	0.2905	0.1460
7.63	1.5268	0.7217	0.3764	0.0206	1.6484	0.3672	0.1553
9.74	2.0398	0.7456	−0.1030	−0.0220	1.7141	0.4373	0.1627
11.63	2.5307	0.7540	−0.3715	−0.0674	1.6245	0.5502	0.1805
15.63	3.7362	0.7684	−0.4501	−0.0771	1.5580	0.6147	0.1971
19.62	5.0713	0.7657	−0.4817	−0.1425	1.7231	0.5489	0.2076

(c) $\phi = 90°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.37	−0.7737	0.6929	1.4038	0.1185	1.4734	0.3426	0.1306
−0.32	−0.0891	0.6686	0.2382	0.0901	1.5090	0.3710	0.1235
3.70	0.6039	0.6859	−0.9465	0.0712	1.4817	0.3465	0.1288
7.71	1.4065	0.7205	−2.1021	0.0951	1.4533	0.2700	0.1411
9.67	1.8706	0.7408	−2.5869	0.1292	1.3622	0.2724	0.1501
11.66	2.3477	0.7450	−2.7015	0.1237	1.2818	0.3248	0.1589
15.74	3.5383	0.7347	−2.4619	0.0791	0.9529	0.5866	0.1734
19.65	5.0550	0.7164	−2.7590	0.0991	1.0890	0.7288	0.2049

Table 20. Data for Configuration BC1T1 at $M = 1.90$ and $\delta = -15°$

(a) $\phi = 0°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.35	−1.0637	0.6778	−1.3786	0.0927	0.0626	−0.0022	0.1455
−0.32	−0.3669	0.6458	−1.2917	0.0942	0.0141	0.0006	0.1384
3.72	0.3739	0.6131	−1.3329	0.0967	−0.0580	0.0143	0.1440
7.73	1.1269	0.5985	−1.0150	0.1010	−0.0512	0.0217	0.1554
9.63	1.5562	0.5906	−0.8744	0.1035	−0.0803	0.0316	0.1594
11.73	2.0975	0.5775	−0.6138	0.1099	−0.1120	0.0395	0.1665
15.67	3.4036	0.5648	0.1535	0.1053	−0.1204	0.0448	0.1749
19.70	4.8824	0.5538	0.5678	0.0928	−0.0829	0.0344	0.1867

(b) $\phi = 45°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.35	−0.9630	0.6779	−0.3020	0.0577	−1.5683	−0.2280	0.1459
−0.34	−0.2836	0.6393	−0.8255	0.0936	−1.0499	−0.2090	0.1429
3.66	0.4363	0.6282	−1.4467	0.0612	−0.3711	−0.1992	0.1437
7.64	1.2258	0.6468	−1.9411	0.0131	0.0283	−0.1075	0.1594
9.69	1.6719	0.6492	−2.0742	−0.0115	0.1268	−0.0522	0.1702
11.65	2.1546	0.6477	−2.1242	−0.0090	0.1651	−0.0030	0.1796
15.68	3.4621	0.6336	−1.8025	−0.0019	0.4257	0.0104	0.1923
19.62	4.8739	0.6103	−1.6586	−0.0824	1.2125	−0.1961	0.2200

(c) $\phi = 90°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.29	−0.7510	0.6828	1.3933	0.0778	−1.4071	−0.2829	0.1313
−0.34	−0.0744	0.6581	0.2562	0.0957	−1.4585	−0.3105	0.1300
3.69	0.6106	0.6857	−0.9188	0.1147	−1.3743	−0.2942	0.1298
7.72	1.4206	0.7232	−2.1215	0.1029	−1.3469	−0.2122	0.1411
9.65	1.8665	0.7397	−2.5297	0.0861	−1.1955	−0.2293	0.1507
11.64	2.3466	0.7411	−2.6491	0.0923	−1.0592	−0.2861	0.1571
15.68	3.5362	0.7284	−2.3879	0.1228	−0.7145	−0.5181	0.1734
19.65	5.0742	0.7300	−2.7088	0.0994	−0.8434	−0.6018	0.1861

Table 21. Data for Configuration BC1 at $M = 1.90$ and $\delta = 0°$

(a) $\phi = 0°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.26	−0.3775	0.4346	−1.4718	−0.0023	0.0265	−0.0068	0.1396
−0.31	−0.0222	0.4055	−0.0408	−0.0031	0.0417	−0.0069	0.1340
3.66	0.3320	0.4337	1.4338	−0.0048	0.0663	−0.0019	0.1340
7.72	0.8112	0.4726	2.8900	−0.0067	0.0731	−0.0055	0.1530
9.66	1.1238	0.4843	3.5792	−0.0073	0.0938	−0.0075	0.1670
11.69	1.5444	0.4833	4.4765	−0.0078	0.0383	0.0094	0.1848
15.72	2.5987	0.4905	6.4453	−0.0081	0.0823	0.0067	0.1918
19.64	3.7745	0.4997	7.9623	−0.0084	0.0361	0.0223	0.2024

(b) $\phi = 45°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.37	−0.3164	0.4385	−1.1462	−0.0004	−0.3726	−0.0588	0.1358
−0.37	−0.0182	0.4032	−0.0125	−0.0012	0.0018	−0.0060	0.1342
3.68	0.2825	0.4322	1.1438	−0.0016	0.3522	0.0452	0.1360
7.69	0.6847	0.4811	2.2618	0.0008	0.7627	0.0695	0.1469
9.65	0.9550	0.4962	2.7900	0.0030	1.0608	0.0471	0.1552
11.64	1.3084	0.5059	3.4302	0.0048	1.4058	0.0195	0.1677
15.69	2.3167	0.5215	4.6762	0.0035	2.2357	−0.1654	0.1825
19.72	3.5214	0.5232	6.0117	−0.0066	2.1279	−0.0036	0.2000

(c) $\phi = 90°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.38	−0.2728	0.4408	−0.7922	−0.0048	−0.0048	0.0023	0.1323
−0.31	−0.0242	0.4090	0.0487	−0.0040	0.0071	0.0033	0.1314
3.65	0.2160	0.4342	0.8762	−0.0027	0.0093	0.0042	0.1344
7.71	0.5903	0.4868	1.6583	−0.0008	0.0342	0.0134	0.1498
9.70	0.8336	0.4916	2.1326	0.0005	0.0174	0.0134	0.1656
11.66	1.1328	0.5016	2.7755	0.0015	0.0582	0.0292	0.1742
15.68	2.0744	0.5241	4.3263	0.0032	0.0358	0.0434	0.1914
19.71	3.3656	0.5352	4.9878	0.0079	−0.0156	0.0439	0.2067

Table 22. Data for Configuration BC2 at $M = 1.90$ and $\delta = 0°$

(a) $\phi = 0°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.30	−0.3743	0.4196	−1.4016	−0.0053	0.0312	0.0048	0.1409
−0.28	−0.0221	0.3917	0.0393	−0.0060	0.0405	0.0026	0.1326
3.70	0.3222	0.4172	1.4918	−0.0073	0.0605	0.0035	0.1387
7.69	0.7846	0.4539	2.8610	−0.0089	0.0733	0.0046	0.1589
9.65	1.0935	0.4603	3.5392	−0.0099	0.0963	0.0021	0.1797
11.64	1.4883	0.4659	4.3821	−0.0105	0.1028	0.0105	0.1915
15.69	2.5526	0.4703	6.3747	−0.0095	0.0897	0.0115	0.1993
19.66	3.7519	0.4779	7.9335	−0.0107	0.1395	0.0056	0.2105

(b) $\phi = 45°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.33	−0.3256	0.4239	−1.0985	−0.0049	−0.3025	−0.0331	0.1398
−0.30	−0.0214	0.3890	0.0412	−0.0056	0.0496	0.0120	0.1355
3.70	0.2676	0.4218	1.1848	−0.0057	0.3788	0.0578	0.1372
7.66	0.6596	0.4590	2.2677	−0.0034	0.7581	0.0695	0.1576
9.69	0.9421	0.4762	2.8130	−0.0011	1.0589	0.0463	0.1661
11.68	1.2916	0.4772	3.4456	0.0010	1.4297	0.0047	0.1873
15.72	2.3038	0.4962	4.6974	−0.0026	2.2388	−0.2092	0.1984
19.67	3.4816	0.4981	5.9980	−0.0116	2.1367	−0.0271	0.2144

(c) $\phi = 90°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.31	−0.2790	0.4385	−0.7620	−0.0062	0.0457	0.0076	0.1272
−0.37	−0.0347	0.4007	0.0289	−0.0058	0.0545	0.0127	0.1275
3.73	0.2149	0.4260	0.8573	−0.0045	0.0848	0.0151	0.1364
7.74	0.5822	0.4738	1.6916	−0.0029	0.0995	0.0173	0.1511
9.65	0.8230	0.4826	2.1494	−0.0019	0.1304	0.0216	0.1624
11.64	1.1391	0.4903	2.8102	−0.0011	0.1148	0.0350	0.1755
15.66	2.0822	0.5131	4.3605	0.0010	0.0974	0.0602	0.1920
19.71	3.3602	0.5232	5.0182	0.0038	0.1099	0.0650	0.2076

Table 23. Data for Configuration BT1 at $M = 1.90$

(a) $\phi = 0°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.32	−0.6235	0.5280	0.6872	0.0901	0.0347	−0.0061	0.1480
−0.32	−0.0649	0.5141	0.1449	0.0945	0.0264	−0.0031	0.1467
3.70	0.4858	0.5287	−0.3417	0.0966	−0.0351	0.0104	0.1444
7.73	1.1635	0.5575	−0.8535	0.1064	−0.0674	0.0216	0.1516
9.65	1.5660	0.5671	−1.0630	0.1114	−0.0692	0.0146	0.1593
11.73	2.0573	0.5633	−1.0918	0.1170	−0.0671	0.0137	0.1706
15.66	3.2290	0.5722	−0.7450	0.1228	−0.0765	0.0157	0.1792
19.74	4.6325	0.5844	−0.5487	0.1232	−0.1611	0.0260	0.1883

(b) $\phi = 45°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.35	−0.6982	0.5453	1.0765	0.0744	−0.3428	0.0720	0.1525
−0.29	−0.0605	0.5122	0.1768	0.0963	−0.0290	0.0122	0.1482
3.66	0.5500	0.5389	−0.6578	0.0810	0.2433	−0.0457	0.1496
7.65	1.2841	0.5812	−1.5364	0.0411	0.3683	−0.0677	0.1648
9.70	1.7335	0.5967	−1.8455	0.0117	0.3930	−0.0607	0.1732
11.66	2.2069	0.6023	−1.9822	−0.0079	0.3074	−0.0316	0.1846
15.68	3.4297	0.6037	−1.8092	−0.0613	0.1846	0.0051	0.1986
19.73	4.8192	0.6063	−1.5519	−0.1321	0.4071	−0.0401	0.2083

(c) $\phi = 90°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.30	−0.7541	0.5560	1.4052	0.1036	−0.0326	0.0221	0.1561
−0.29	−0.0628	0.5123	0.2179	0.0963	−0.0175	0.0226	0.1515
3.63	0.6122	0.5522	−0.9218	0.0970	−0.0085	0.0093	0.1521
7.68	1.3985	0.6058	−1.9926	0.1079	0.0216	0.0063	0.1640
9.65	1.8317	0.6119	−2.3578	0.1099	0.0432	0.0101	0.1713
11.67	2.3427	0.6085	−2.5135	0.1107	0.0721	0.0135	0.1817
15.67	3.5427	0.6030	−2.1768	0.1048	0.0756	0.0211	0.1914
19.68	4.9682	0.6022	−2.1324	0.1029	0.1110	0.0283	0.2060

Table 24. Data for Configuration BT2 at $M = 1.90$

(a) $\phi = 0°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.58	−0.6482	0.6125	0.6534	0.0069	−0.0525	0.0048	0.1522
−2.61	−0.3640	0.6138	0.3975	0.0094	−0.0455	0.0057	0.1497
−0.60	−0.0908	0.6147	0.1058	0.0104	−0.0051	0.0016	0.1460
1.40	0.1987	0.6153	−0.2106	0.0086	0.0624	−0.0162	0.1479
3.42	0.4829	0.6147	−0.4727	0.0070	0.0833	−0.0125	0.1508
5.43	0.8056	0.6191	−0.7421	0.0037	0.0952	−0.0117	0.1547
7.38	1.1631	0.6202	−1.0006	−0.0055	0.1662	−0.0332	0.1652
9.39	1.5769	0.6248	−1.1947	−0.0121	0.1858	−0.0298	0.1736
11.45	2.0746	0.6292	−1.2356	−0.0204	0.2330	−0.0450	0.1811
13.40	2.6482	0.6305	−1.1241	−0.0144	0.2085	−0.0279	0.1889
16.41	3.5896	0.6251	−0.9009	−0.0234	0.2360	−0.0399	0.1968
19.40	4.6781	0.6181	−0.9308	−0.0456	0.2922	−0.0496	0.2107

(b) $\phi = 45°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.56	−0.7326	0.6254	1.0927	−0.0101	−0.2723	0.0444	0.1676
−2.60	−0.4026	0.6112	0.6154	0.0045	−0.1814	0.0349	0.1583
−0.59	−0.0895	0.6120	0.1476	0.0099	−0.0443	0.0096	0.1493
1.47	0.2419	0.6202	−0.3447	0.0041	0.0719	−0.0054	0.1493
3.40	0.5612	0.6301	−0.8093	−0.0087	0.1611	−0.0179	0.1586
5.38	0.9099	0.6513	−1.2399	−0.0262	0.1901	−0.0174	0.1675
7.39	1.3008	0.6588	−1.6736	−0.0535	0.1786	−0.0100	0.1808
9.38	1.7428	0.6569	−2.0072	−0.0859	0.0930	0.0184	0.1942
11.39	2.2488	0.6556	−2.1846	−0.1103	−0.1141	0.0812	0.2050
13.38	2.8531	0.6477	−2.1955	−0.1322	−0.3055	0.1245	0.2183
16.46	3.8768	0.6353	−2.1494	−0.1916	−0.3365	0.1463	0.2366
19.42	4.9485	0.6221	−2.1389	−0.2346	−0.2384	0.1193	0.2481

(c) $\phi = 90°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.56	−0.7710	0.6397	1.3196	0.0193	0.0371	−0.0014	0.1622
−2.63	−0.4373	0.6130	0.7788	0.0135	0.0102	−0.0036	0.1588
−0.52	−0.0850	0.6110	0.1795	0.0102	−0.0348	0.0185	0.1487
1.43	0.2365	0.6206	−0.3598	0.0104	−0.0621	0.0214	0.1481
3.36	0.5633	0.6395	−0.8780	0.0102	−0.1005	0.0318	0.1602
5.41	0.9408	0.6599	−1.4098	0.0132	−0.1446	0.0405	0.1767
7.44	1.3462	0.6722	−1.8690	0.0116	−0.1941	0.0642	0.1864
9.44	1.7866	0.6706	−2.1818	0.0026	−0.2585	0.0873	0.1959
11.44	2.2852	0.6588	−2.2989	−0.0119	−0.3408	0.1168	0.1976
13.37	2.8640	0.6463	−2.2507	−0.0224	−0.3263	0.1263	0.2028
16.44	3.8470	0.6366	−2.0621	−0.0375	−0.2955	0.1221	0.2167
19.41	4.9158	0.6324	−2.0222	−0.0503	−0.2403	0.1232	0.2303

Table 25. Data for Configuration B at $M = 1.90$

(a) $\phi = 0°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.30	−0.2471	0.3984	−0.9110	−0.0007	0.0341	−0.0005	0.1357
−0.31	−0.0291	0.3688	0.0071	−0.0018	0.0512	0.0005	0.1304
3.68	0.1844	0.3932	0.9601	−0.0028	0.0478	0.0000	0.1325
7.66	0.5390	0.4438	1.8027	−0.0035	0.0782	0.0041	0.1580
9.71	0.7910	0.4531	2.3283	−0.0036	0.0748	0.0010	0.1791
11.65	1.0885	0.4499	2.9750	−0.0045	0.0897	0.0052	0.2014
15.69	2.0243	0.4608	4.6530	−0.0059	0.1180	−0.0030	0.2131
19.67	3.1886	0.4778	5.7796	−0.0071	0.1424	−0.0112	0.2212

(b) $\phi = 45°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.33	−0.2557	0.3953	−0.9088	−0.0001	0.0452	0.0051	0.1393
−0.35	−0.0322	0.3654	0.0010	−0.0019	0.0408	0.0036	0.1322
3.72	0.1954	0.3932	0.9663	−0.0006	0.0482	0.0076	0.1372
7.69	0.5458	0.4223	1.8087	0.0030	0.0408	0.0138	0.1589
9.64	0.7882	0.4339	2.2949	0.0046	0.0577	0.0117	0.1675
11.65	1.1041	0.4308	2.9575	0.0062	0.0835	0.0170	0.1910
15.64	2.0270	0.4492	4.5620	0.0115	0.1187	0.0173	0.1982
19.64	3.2243	0.4649	5.5397	0.0157	0.2754	−0.0197	0.2185

(c) $\phi = 90°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.35	−0.2623	0.3999	−0.8943	−0.0029	0.0214	0.0055	0.1319
−0.28	−0.0258	0.3742	0.0356	−0.0021	0.0392	0.0058	0.1267
3.72	0.1984	0.3934	0.9575	−0.0014	0.0425	0.0125	0.1355
7.65	0.5431	0.4187	1.8185	−0.0007	0.0473	0.0132	0.1658
9.71	0.8060	0.4378	2.3168	0.0007	0.0661	0.0167	0.1735
11.70	1.1383	0.4475	2.9466	0.0018	0.0661	0.0261	0.1882
15.67	2.0800	0.4714	4.3926	0.0038	0.0405	0.0442	0.2122
19.70	3.3468	0.4893	5.0278	0.0071	0.1336	0.0206	0.2338

Table 28. Data for Configuration B at $M = 2.16$

(a) $\phi = 0°$

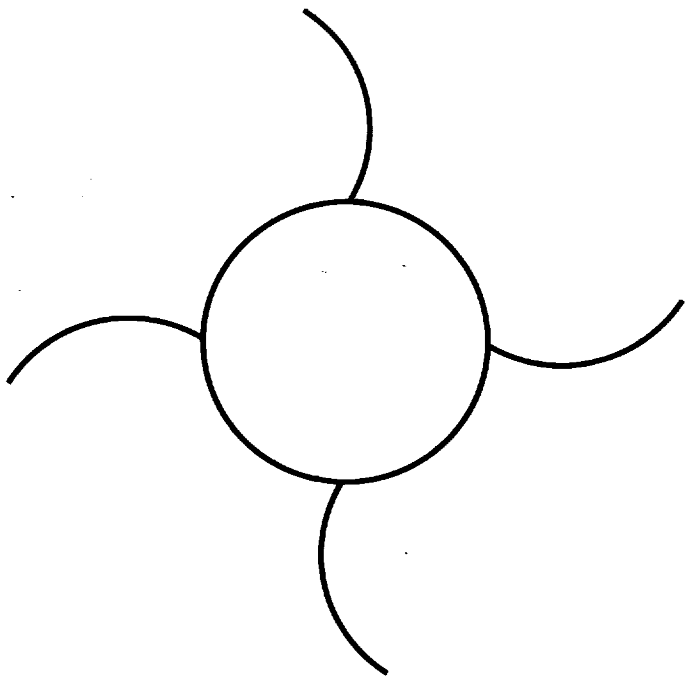
ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.12	−0.2338	0.3781	−1.0527	−0.0006	0.0136	−0.0065	0.1434
−2.22	−0.1167	0.3618	−0.6101	−0.0006	0.0151	−0.0037	0.1412
−0.14	−0.0104	0.3582	−0.0695	−0.0010	0.0186	−0.0050	0.1312
1.87	0.0942	0.3623	0.4564	−0.0007	0.0266	−0.0044	0.1316
3.80	0.2080	0.3716	0.9148	−0.0007	0.0255	−0.0034	0.1404
5.85	0.3788	0.3926	1.3788	−0.0003	0.0284	−0.0054	0.1479
7.88	0.5963	0.4046	1.8402	−0.0001	0.0376	−0.0032	0.1602
9.86	0.8721	0.4108	2.4259	0.0003	0.0585	−0.0121	0.1723
11.82	1.2533	0.4077	3.1053	0.0002	0.0656	−0.0135	0.1829
13.84	1.7018	0.4074	3.8366	0.0005	0.0869	−0.0162	0.1916
16.89	2.5226	0.4162	4.5993	0.0007	0.0741	0.0008	0.2026
19.83	3.3600	0.4211	5.0860	0.0011	0.0621	0.0071	0.2125

(b) $\phi = 45°$

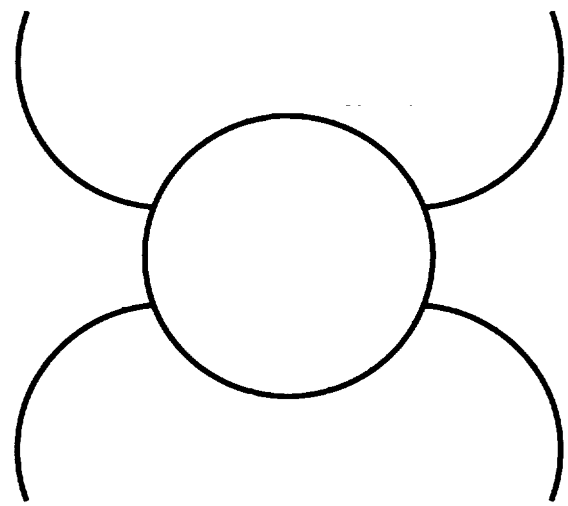
ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.14	−0.2518	0.3795	−0.9564	0.0000	−0.0794	0.0260	0.1488
−2.17	−0.1224	0.3636	−0.5333	−0.0002	−0.0633	0.0231	0.1379
−0.17	−0.0103	0.3607	−0.0539	−0.0006	−0.0067	0.0119	0.1274
1.83	0.1001	0.3620	0.4141	−0.0008	0.0405	0.0058	0.1314
3.87	0.2332	0.3720	0.8728	−0.0003	0.0671	0.0056	0.1451
5.81	0.3879	0.3916	1.3052	0.0002	0.0612	0.0072	0.1536
7.86	0.6120	0.4064	1.7956	0.0016	0.0682	0.0091	0.1610
9.86	0.8853	0.4085	2.3738	0.0030	0.0975	0.0068	0.1757
11.83	1.2664	0.4106	3.0703	0.0041	0.1180	0.0025	0.1860
13.81	1.7154	0.4127	3.7606	0.0056	0.1371	0.0077	0.1925
16.86	2.5454	0.4255	4.4007	0.0062	0.1640	0.0107	0.1998
19.80	3.4103	0.4361	4.7949	0.0082	0.1860	0.0150	0.2070

(c) $\phi = 90°$

ALPHA	CN	CA	CM	CLB	CNB	CY	CAC
−4.19	−0.2706	0.3794	−0.8498	−0.0004	−0.0084	0.0273	0.1444
−2.15	−0.1297	0.3610	−0.4225	−0.0004	−0.0050	0.0301	0.1395
−0.17	−0.0163	0.3583	−0.0092	−0.0008	−0.0011	0.0287	0.1293
1.89	0.1064	0.3657	0.4300	−0.0007	−0.0008	0.0310	0.1299
3.85	0.2421	0.3801	0.8445	−0.0010	−0.0079	0.0338	0.1370
5.88	0.4096	0.3967	1.2903	−0.0013	−0.0110	0.0379	0.1508
7.88	0.6346	0.4117	1.7518	−0.0013	−0.0186	0.0509	0.1589
9.83	0.9061	0.4164	2.3015	−0.0017	−0.0347	0.0626	0.1720
11.81	1.2924	0.4238	2.9907	−0.0024	−0.0052	0.0652	0.1802
13.83	1.7548	0.4278	3.6599	−0.0026	0.0105	0.0705	0.1920
16.83	2.5959	0.4426	4.2715	−0.0037	0.0128	0.0793	0.2049
19.87	3.5002	0.4547	4.5762	−0.0044	−0.0083	0.0964	0.2081



(a) Traditional.



(b) Opposing pairs.

Figure 1. Wraparound fin arrangements.

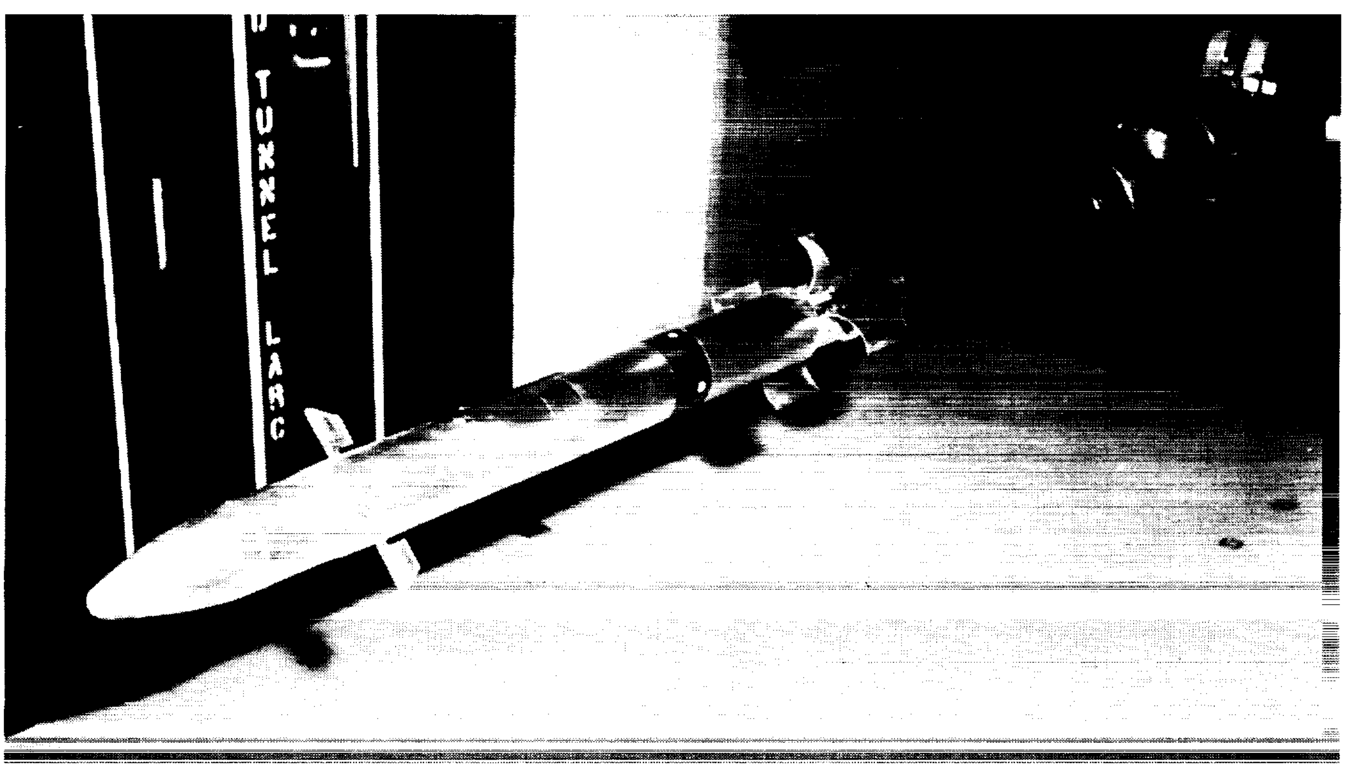


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Figure 2. Photograph of baseline model installed in the Langley Unitary Plan Wind Tunnel.

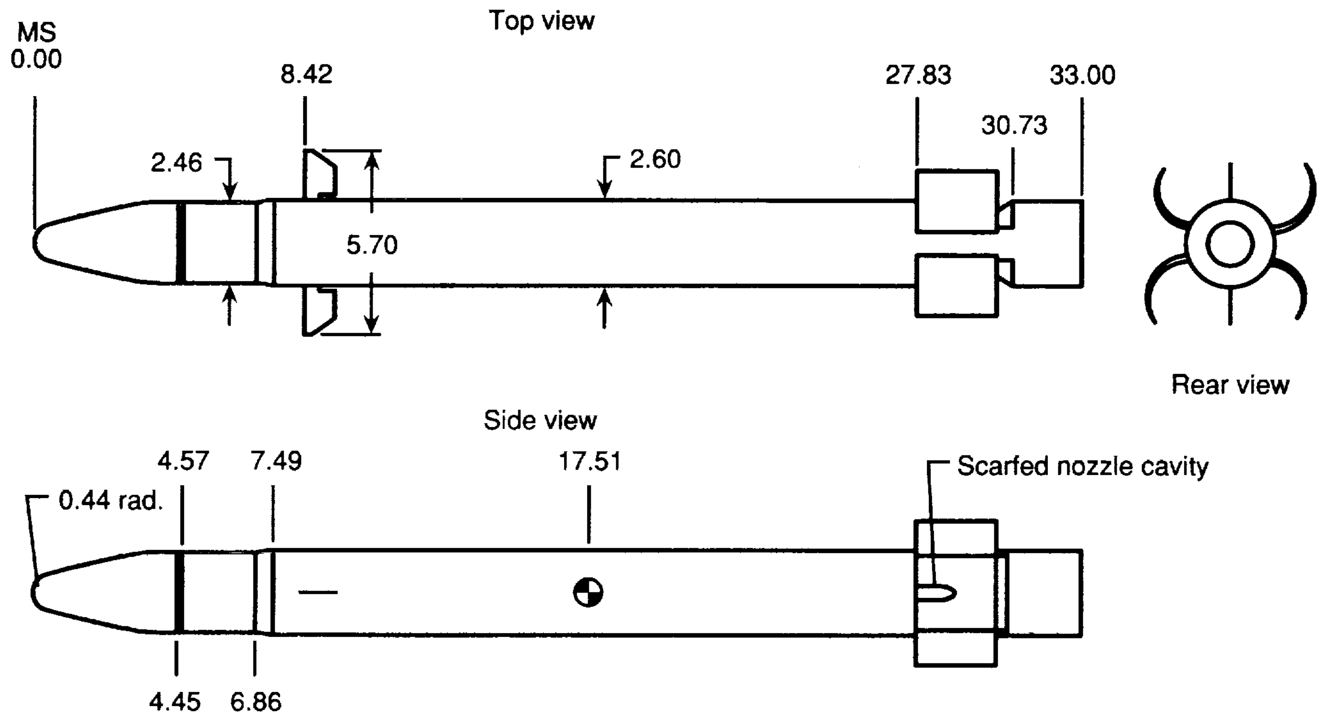

Figure 3. Three-view line drawings of model. All dimensions are given in inches.

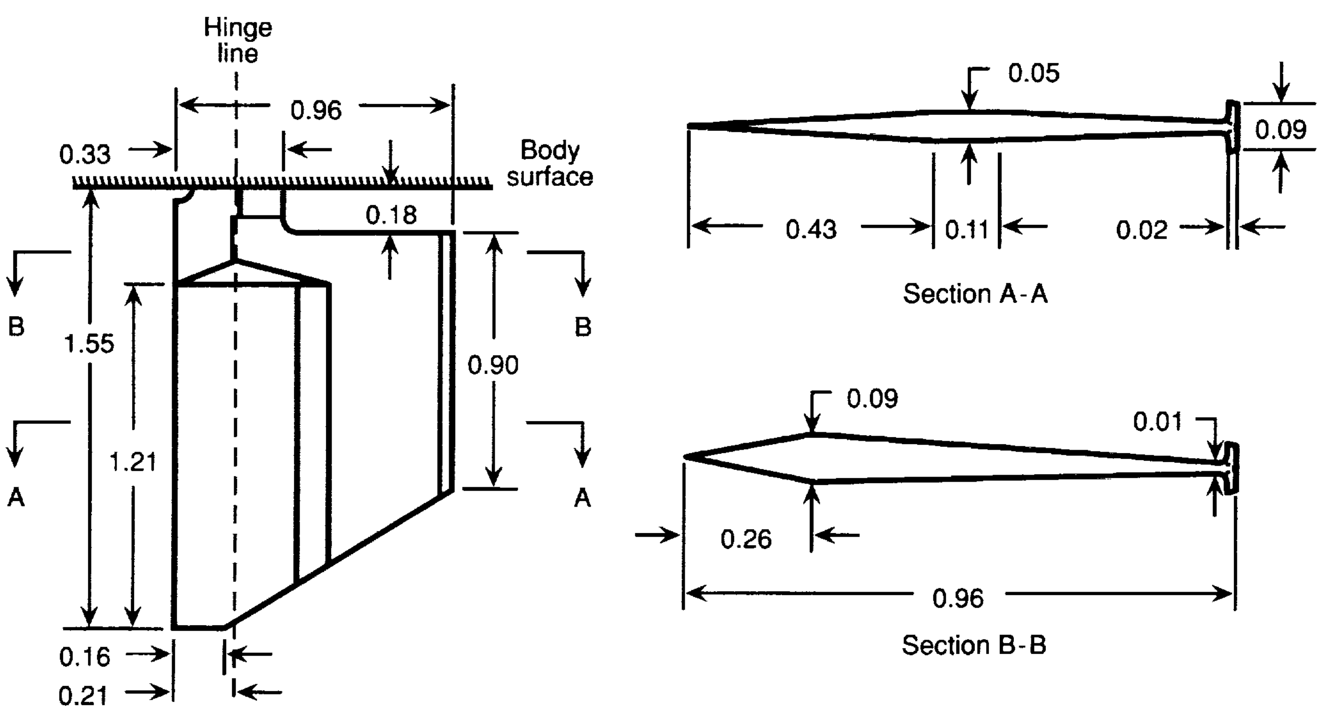

Figure 4. Drawings of canard. All dimensions are given in inches.

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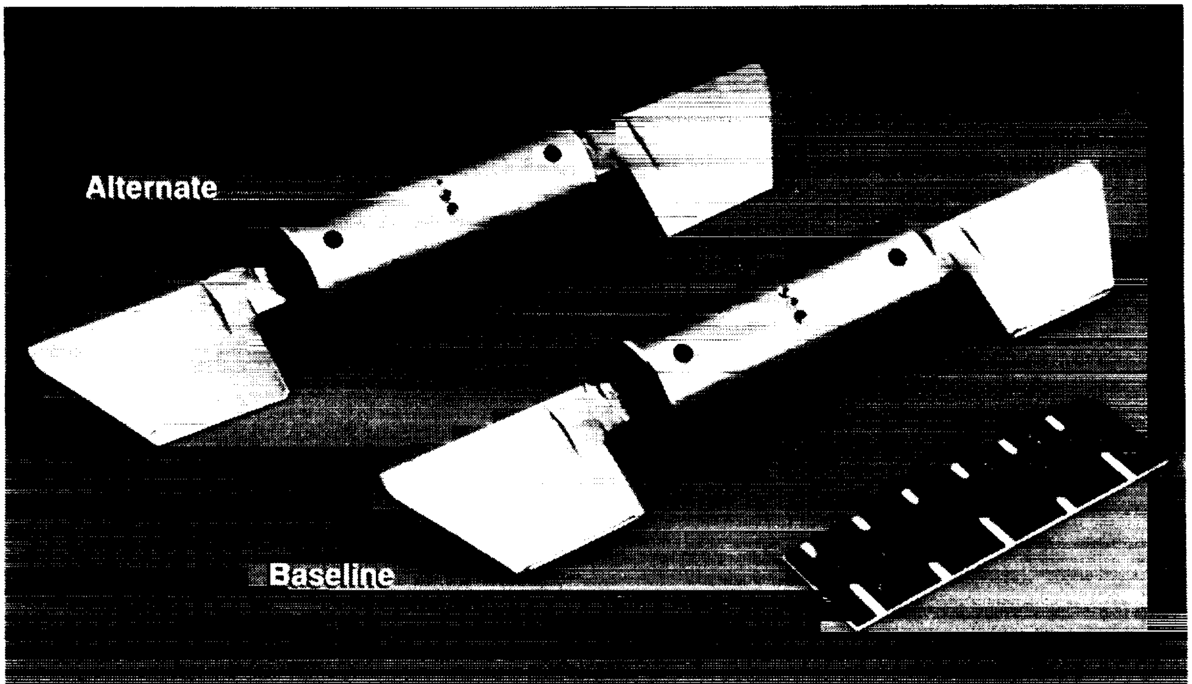
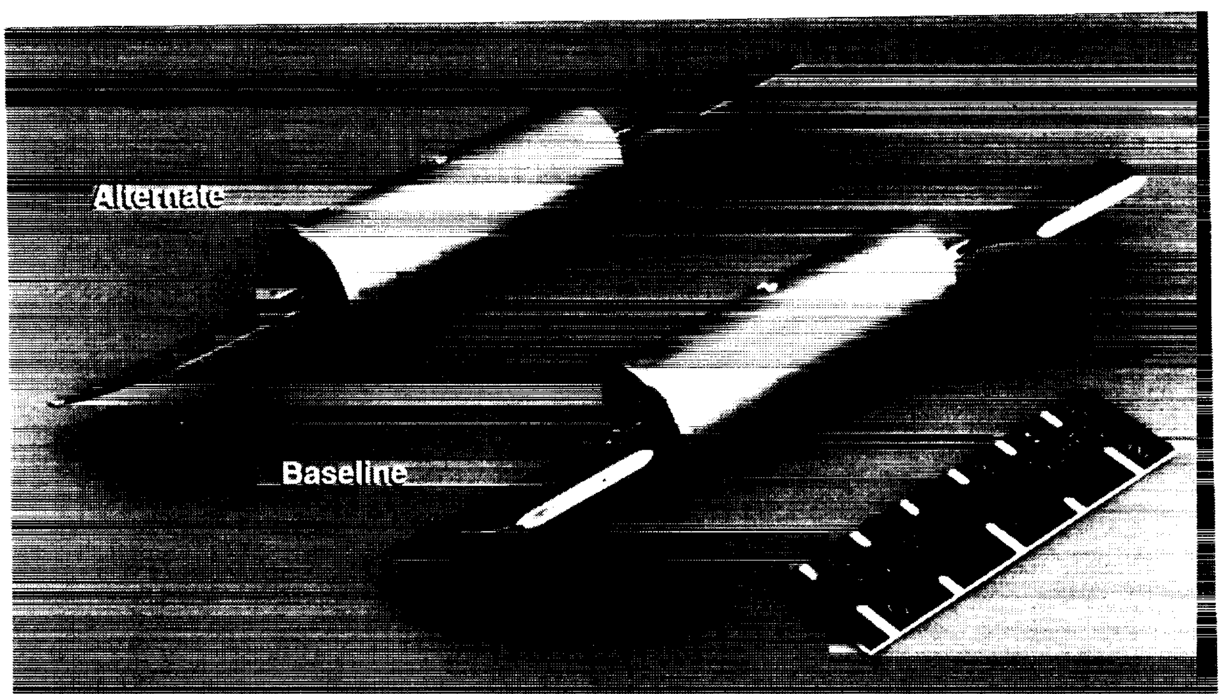


L-89-3843

(a) Planform view.



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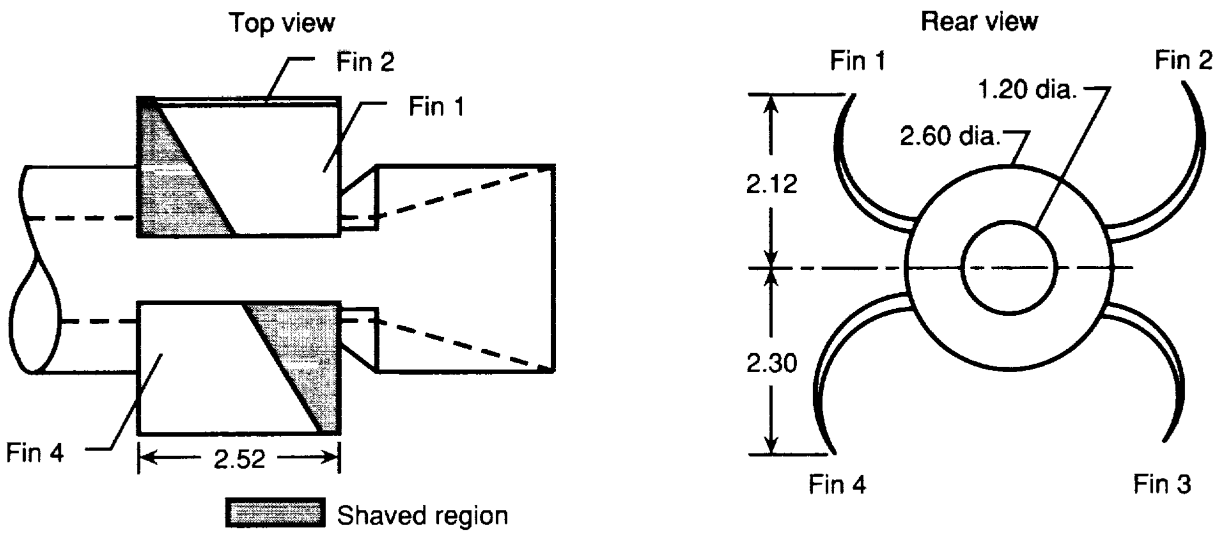
(b) Edge view.

Figure 5. Photographs of canard.



	Fins	
	1 & 3	2 & 4
Inside r	1.10	1.20
Outside r	1.20	1.30

Fins	Tip-to-tip dimension
1 & 3	6.29
2 & 4	6.59

Figure 6. Sketches of aft end of model and baseline tail fins. All dimensions are given in inches.

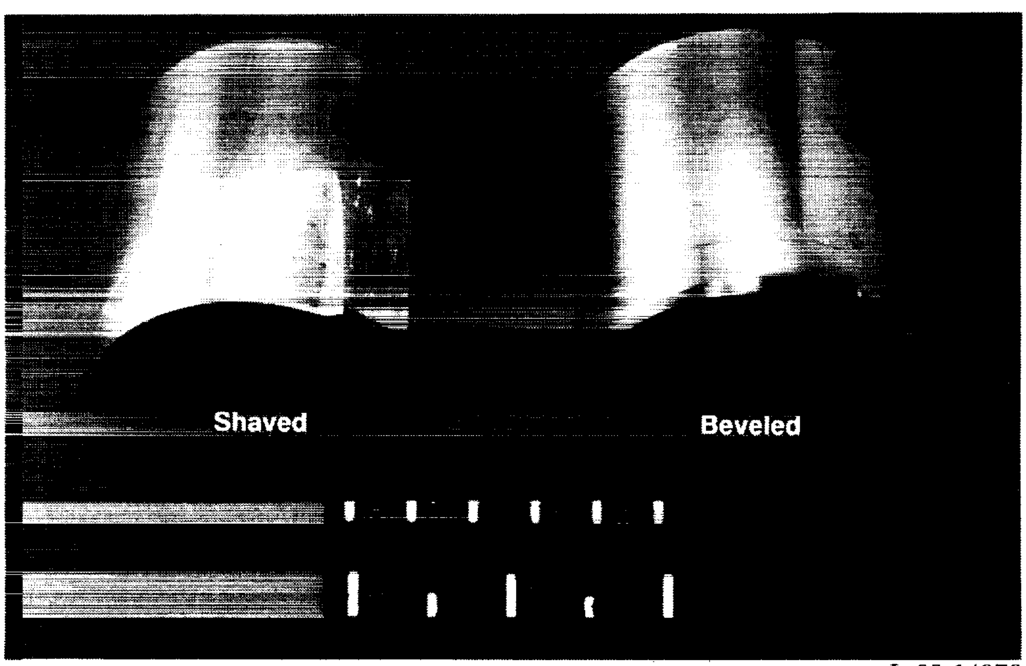


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Figure 7. Photograph of shaved and beveled tail fins.

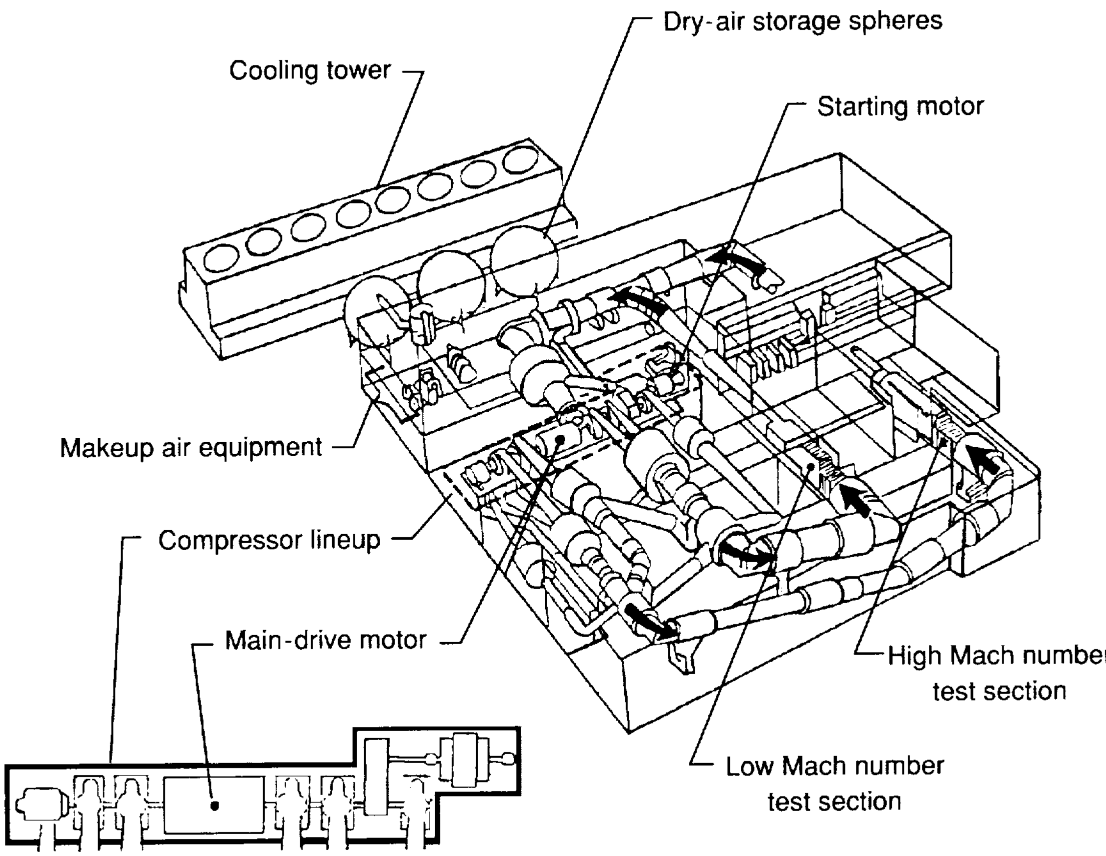
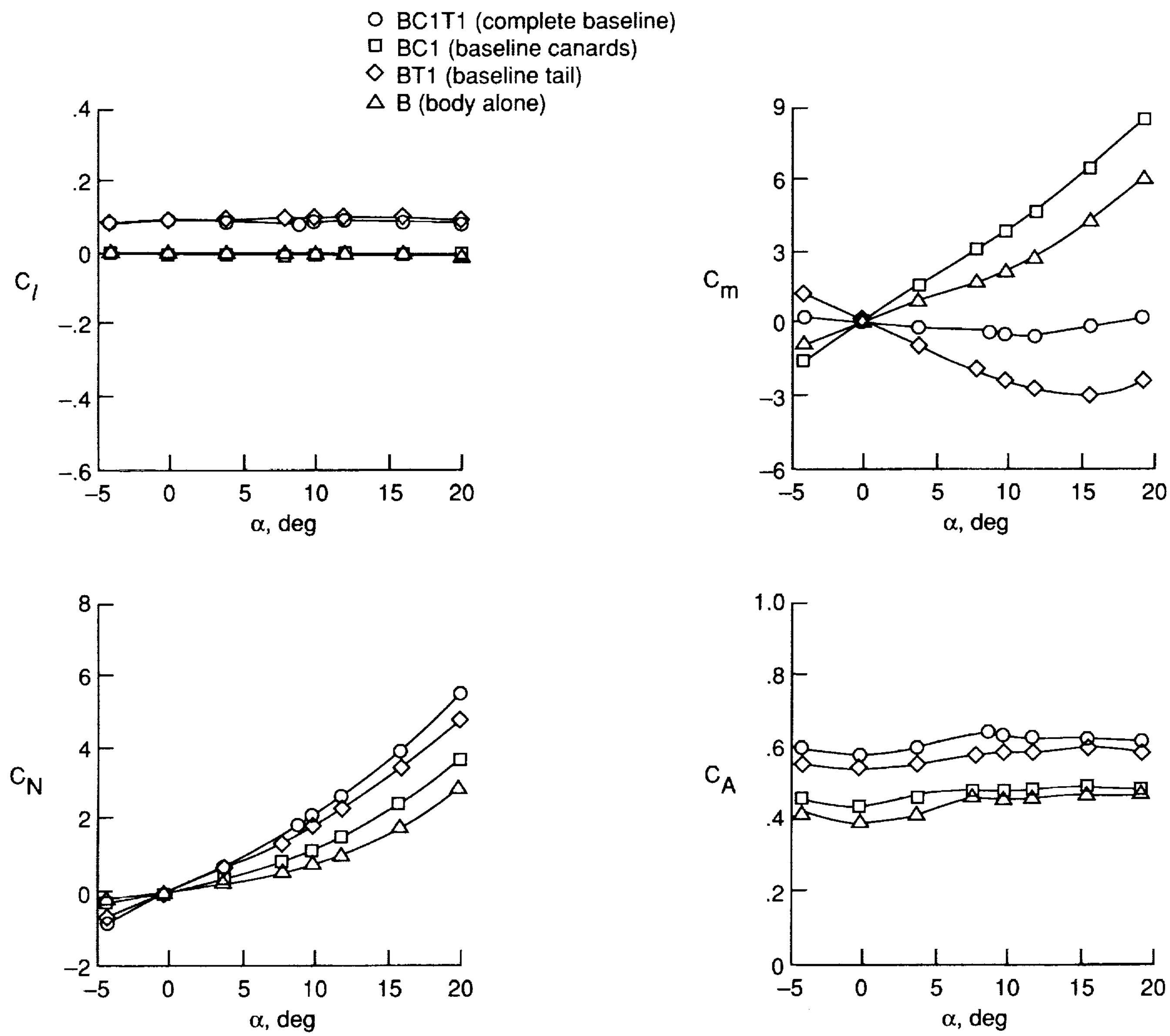
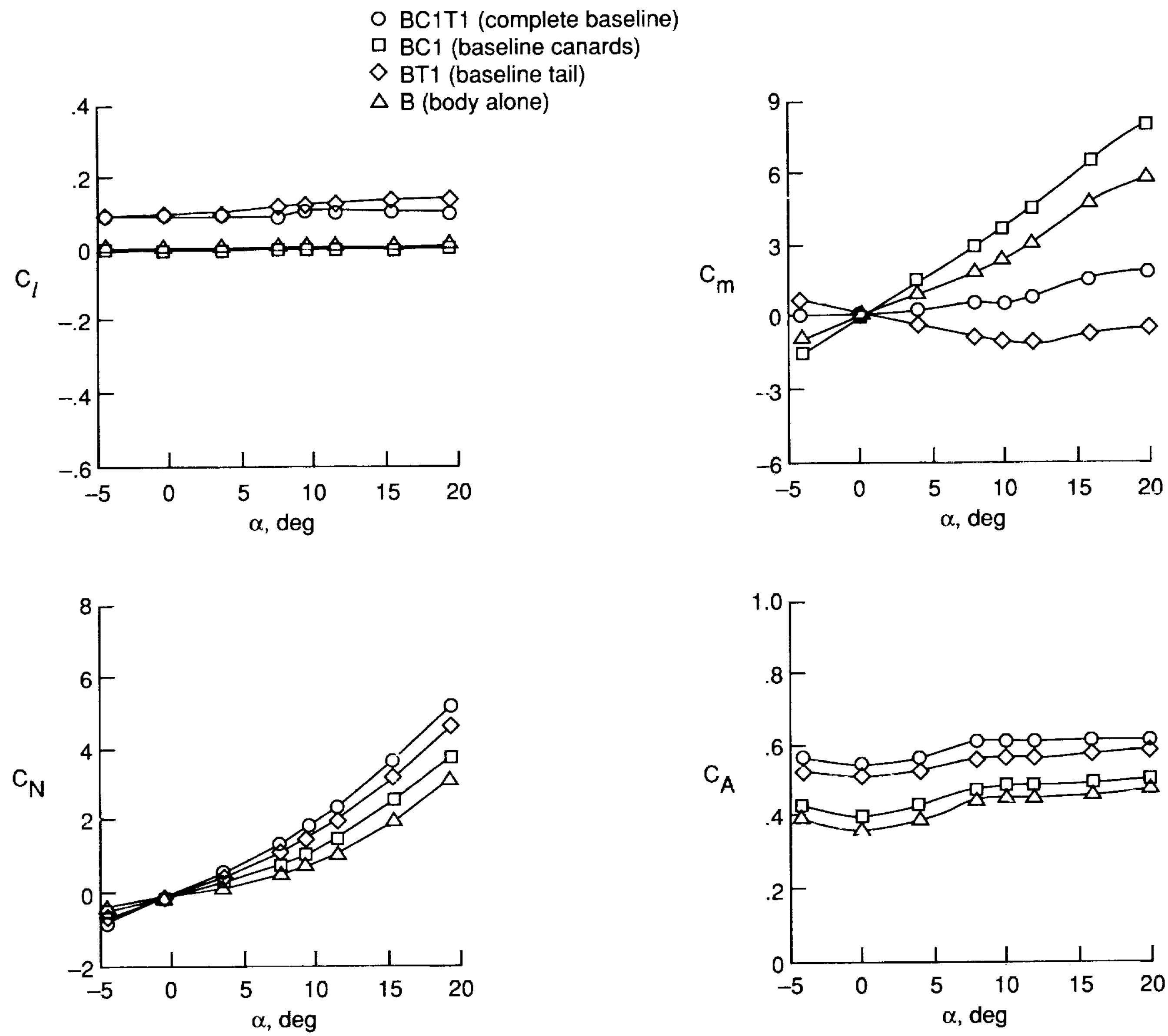


Figure 8. Schematic drawing of the Langley Unitary Plan Wind Tunnel.



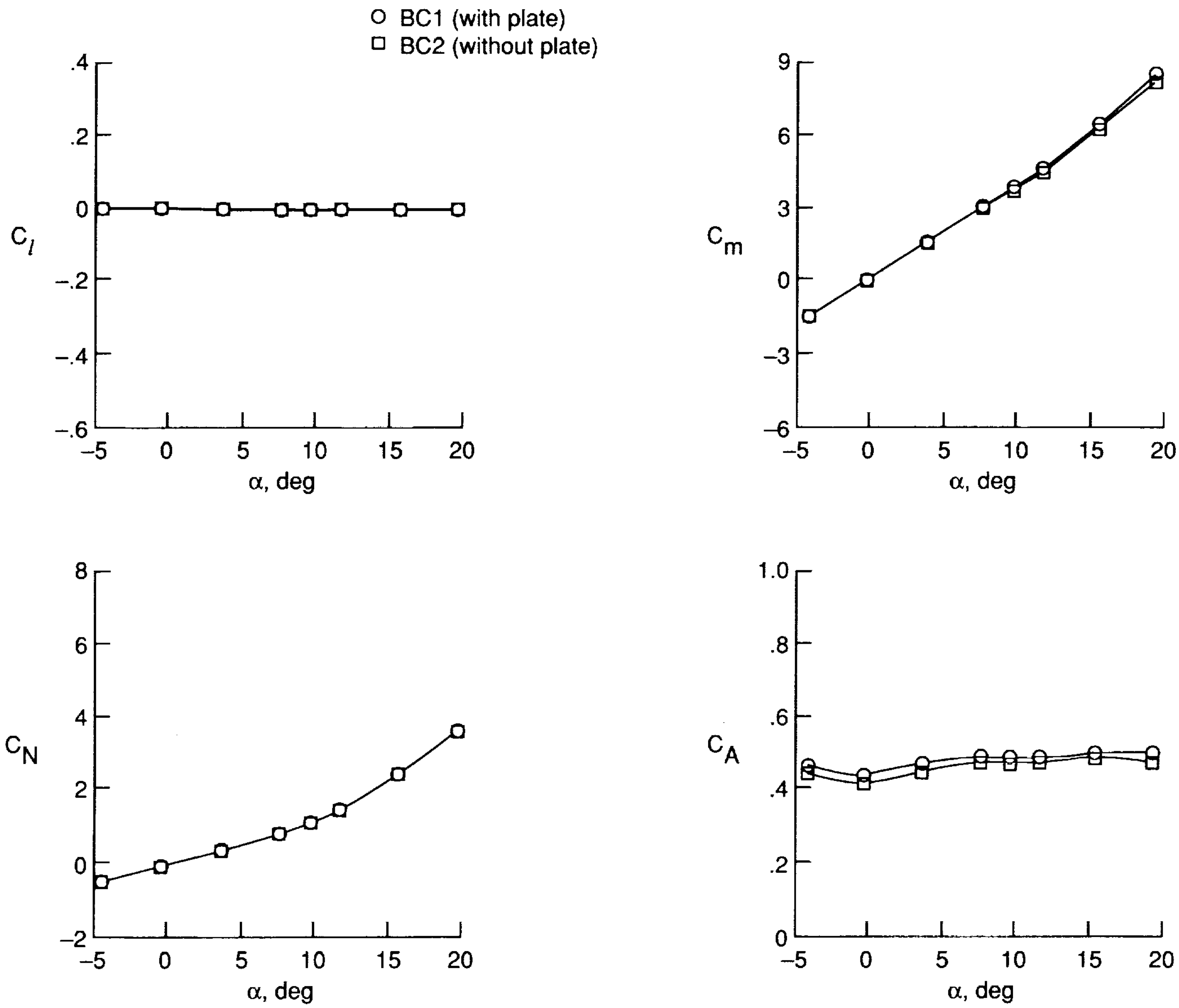
(a) $M = 1.60$.

Figure 9. Component buildup effects. $\delta = 0°$; $\phi = 0°$.



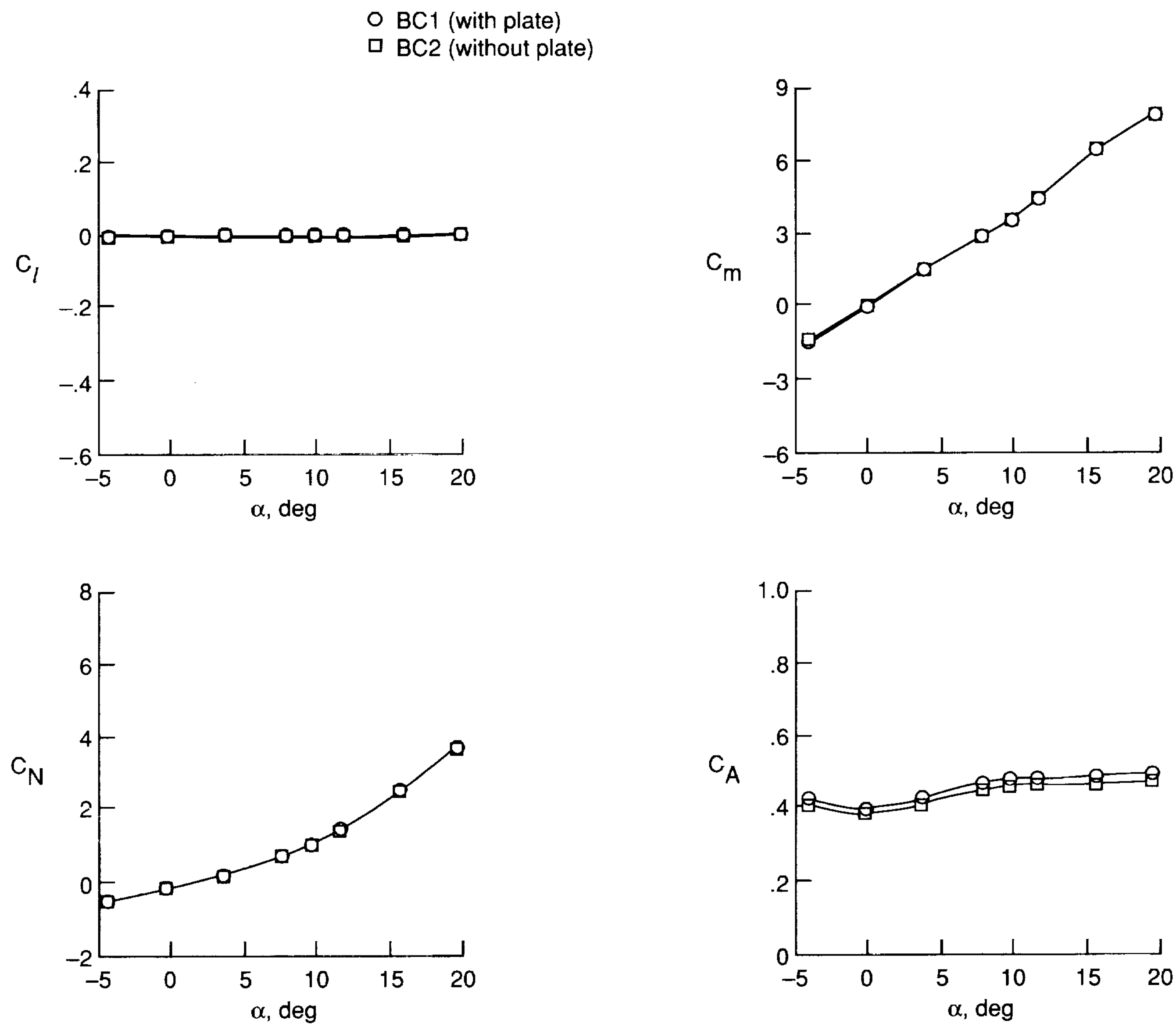
(b) $M = 1.90$.

Figure 9. Concluded.



(a) $M = 1.60$.

Figure 10. Effect of canard trailing-edge plate. $\delta = 0°$; $\phi = 0°$.



(b) $M = 1.90$.

Figure 10. Concluded.

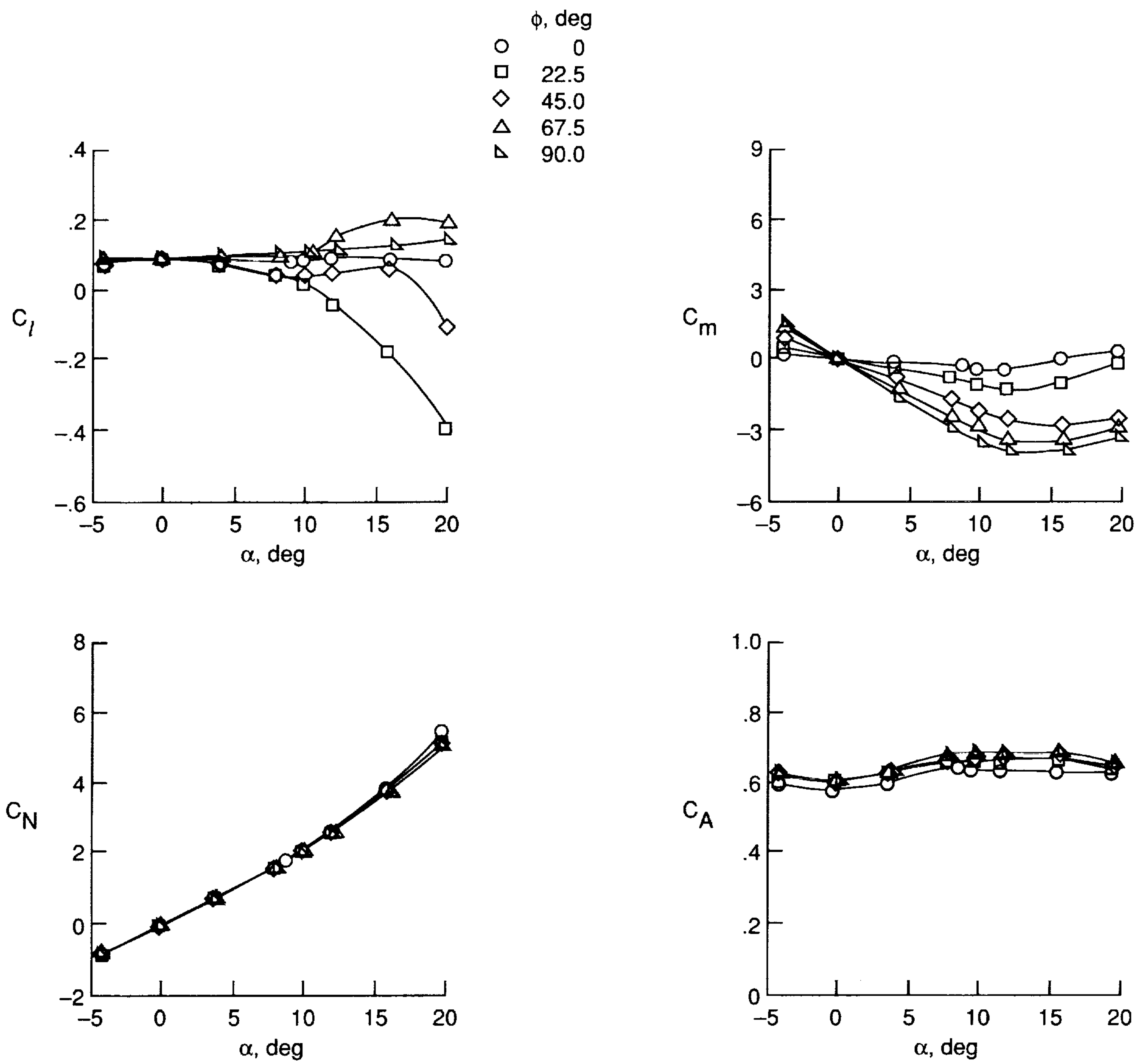
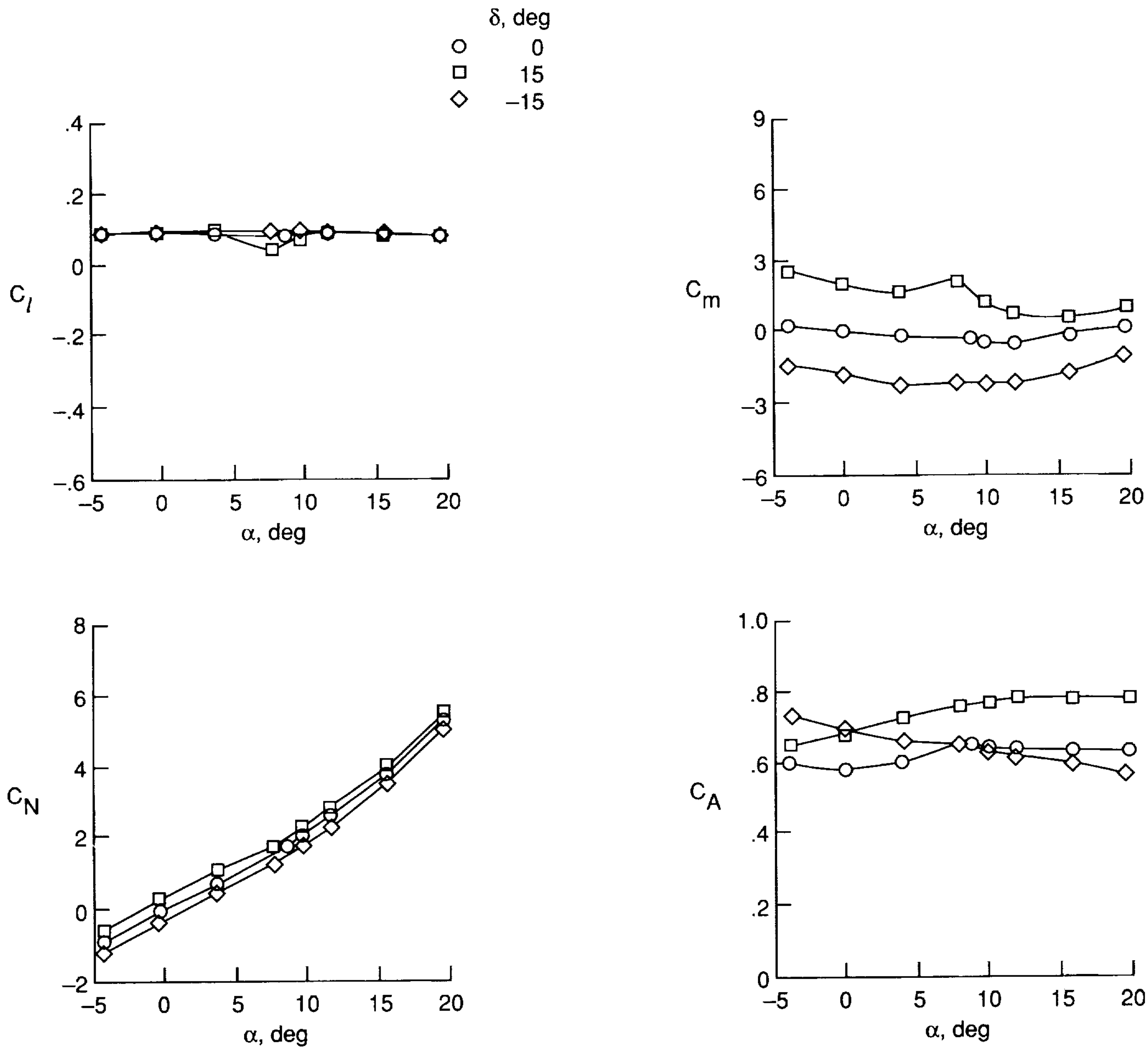
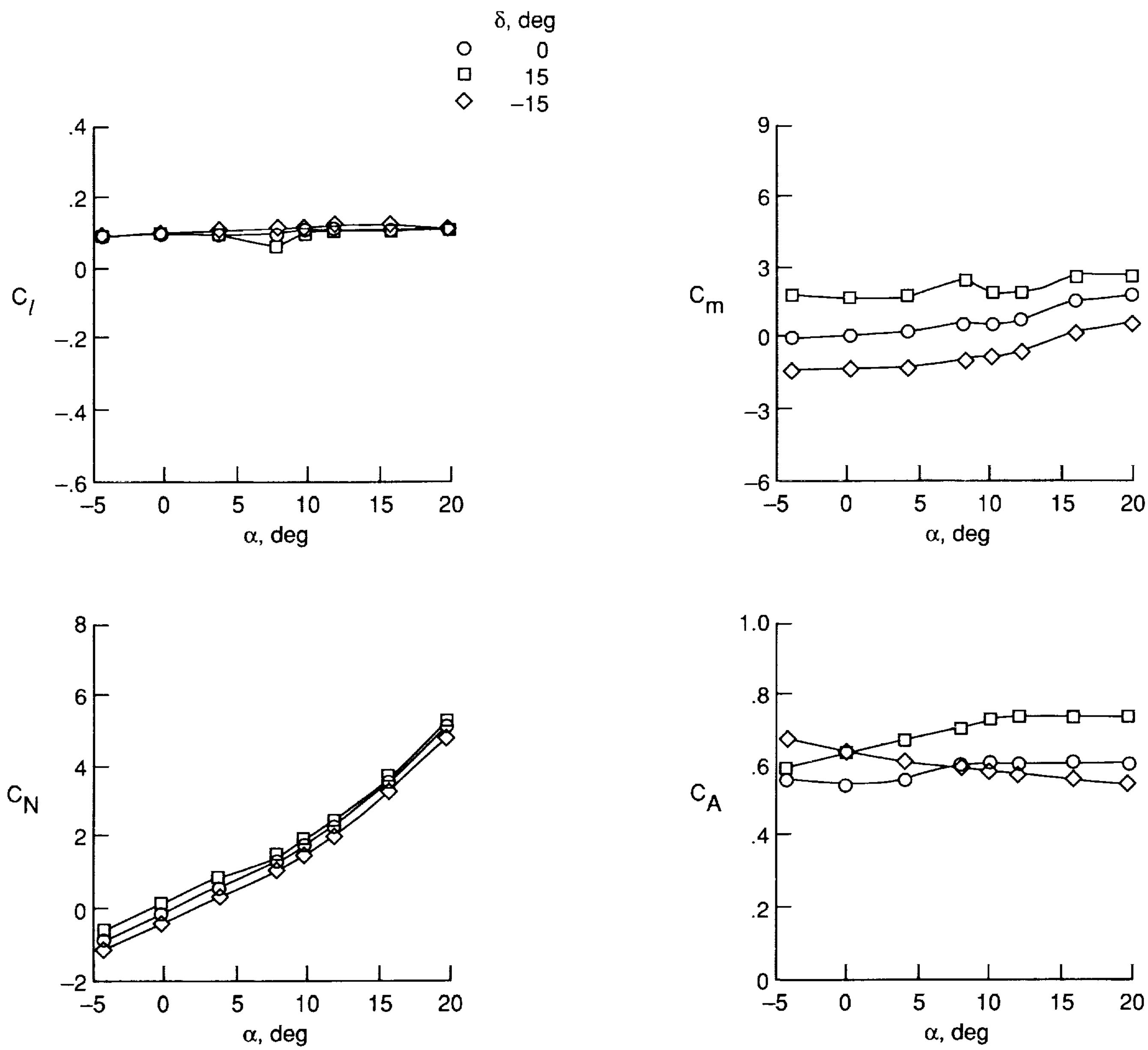


Figure 11. Effect of roll angle. BC1T1; $M = 1.60$; $\delta = 0^\circ$.



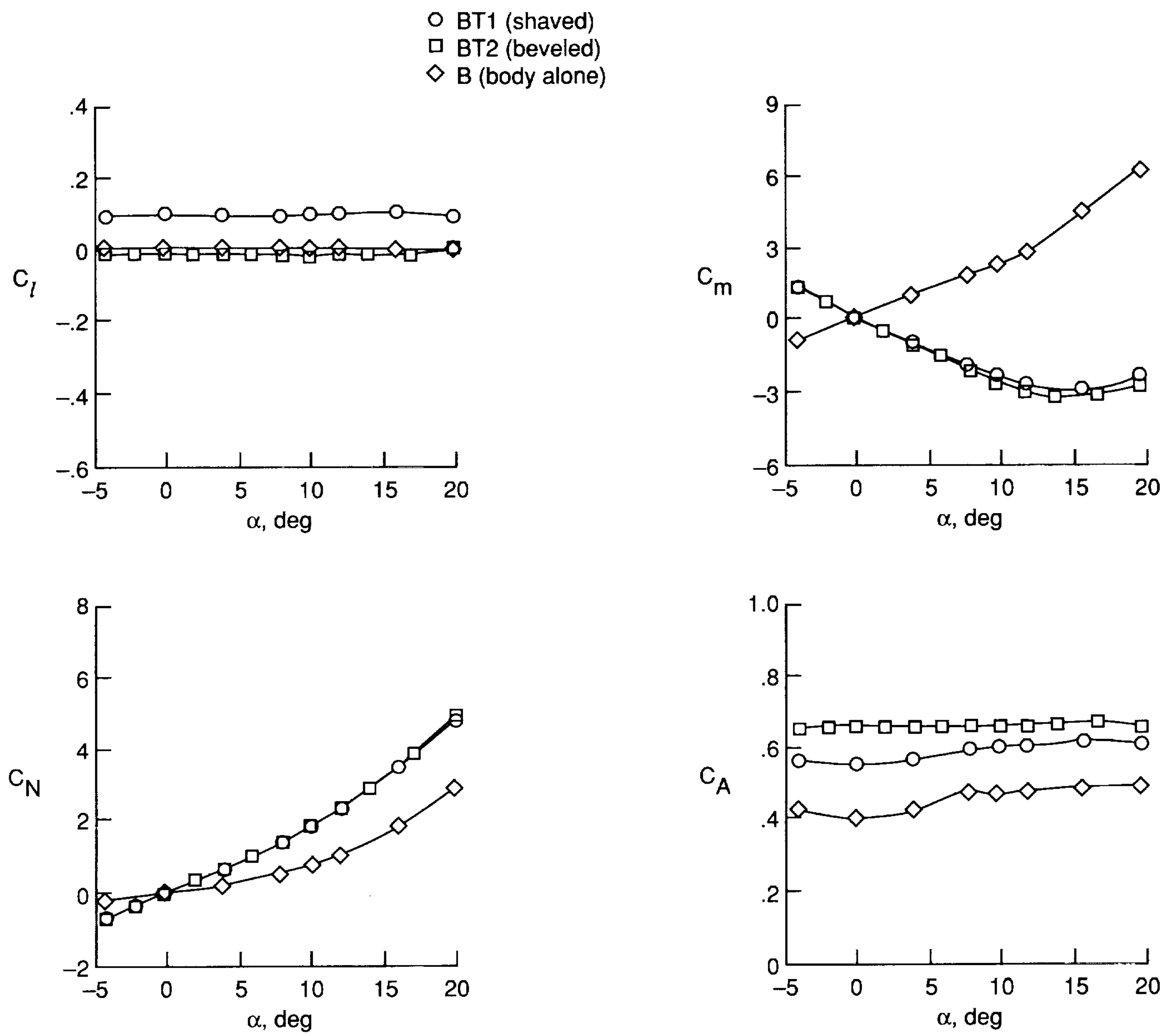
(a) $M = 1.60$.

Figure 12. Effect of canard deflection. BC1T1; $\phi = 0^{\circ}$.



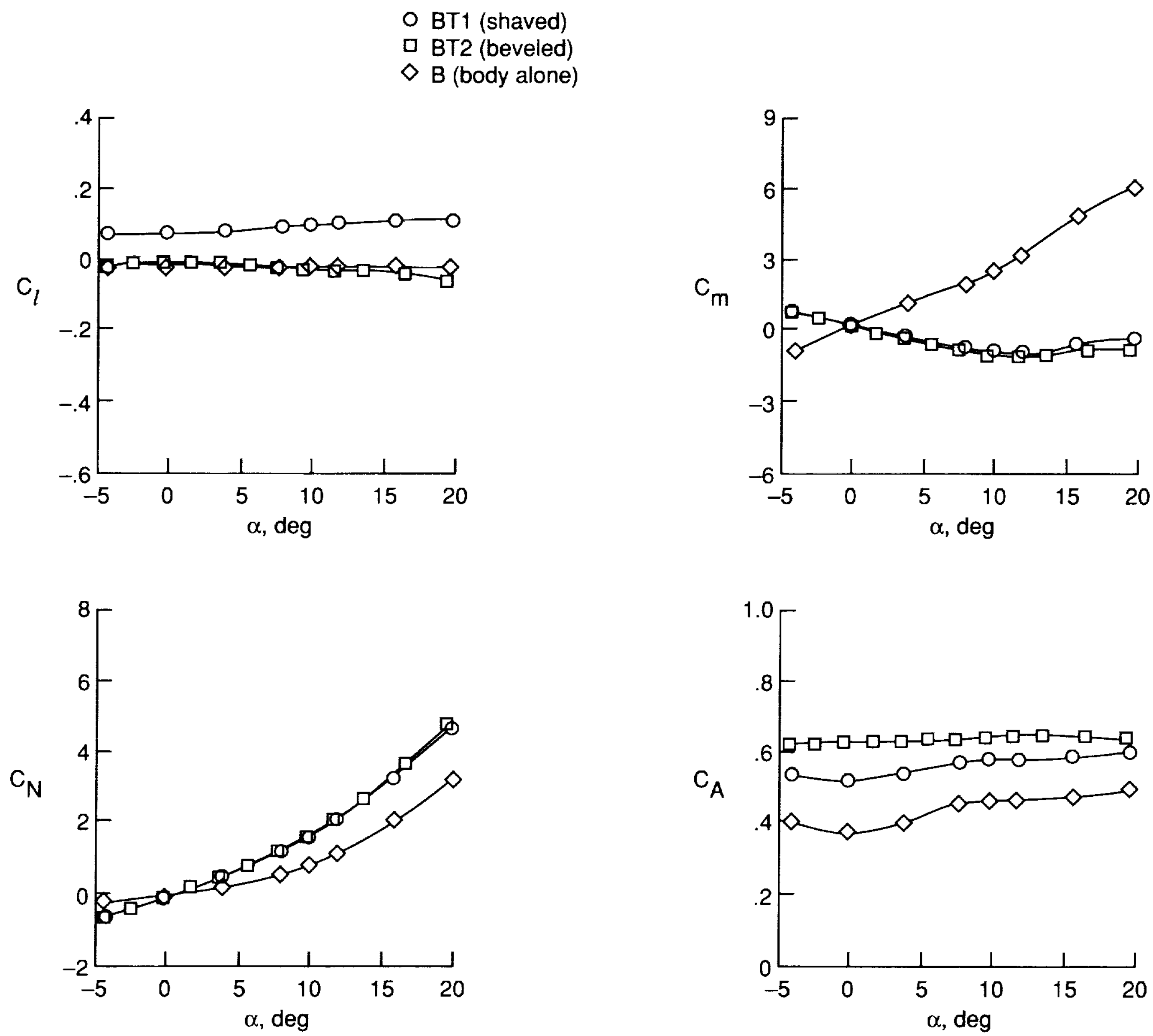
(b) $M = 1.90$.

Figure 12. Concluded.



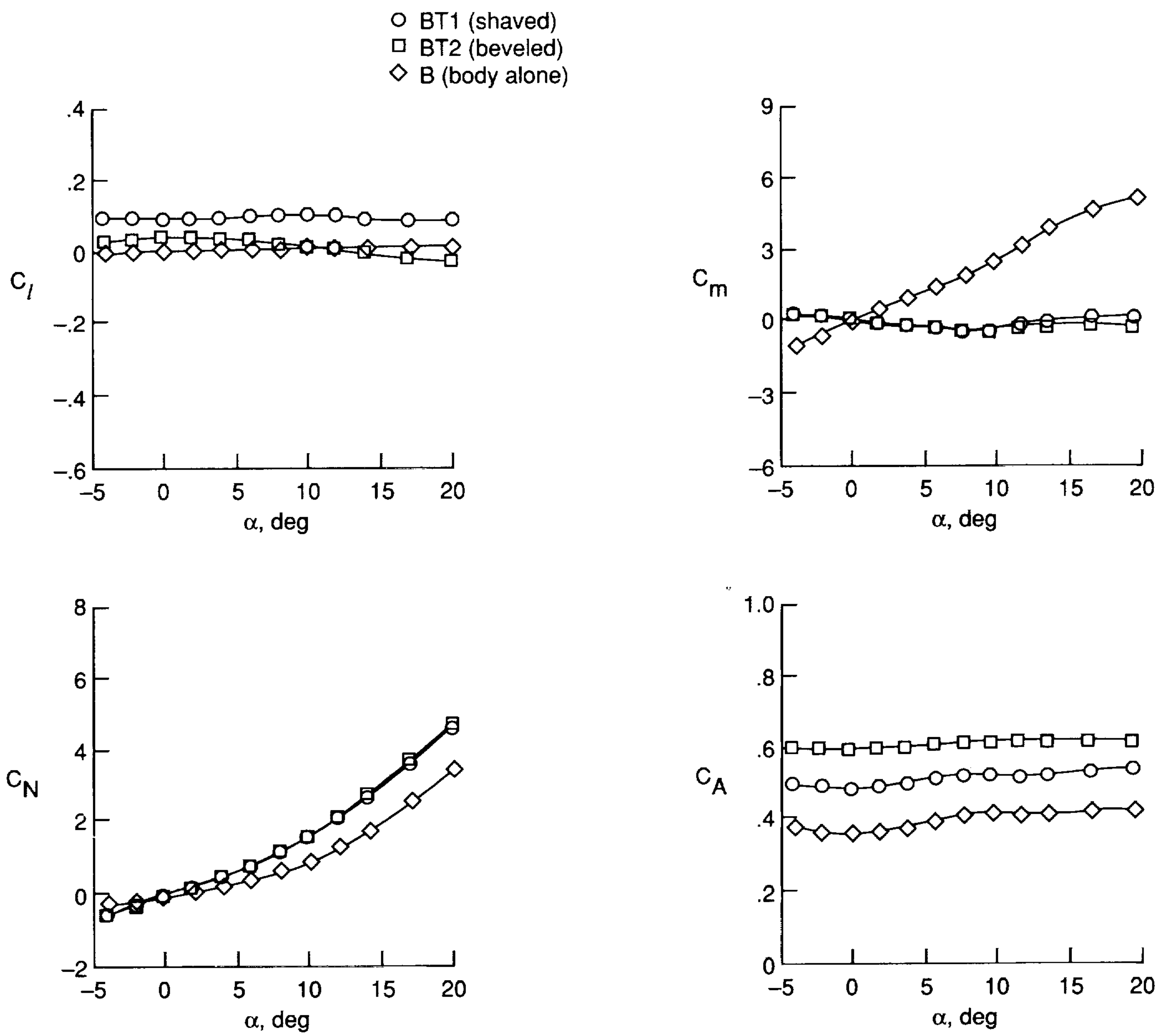
(a) $M = 1.60$.

Figure 13. Effect of tail shaping with $\phi = 0°$.



(b) $M = 1.90$.

Figure 13. Continued.



(c) $M = 2.16$.

Figure 13. Concluded.

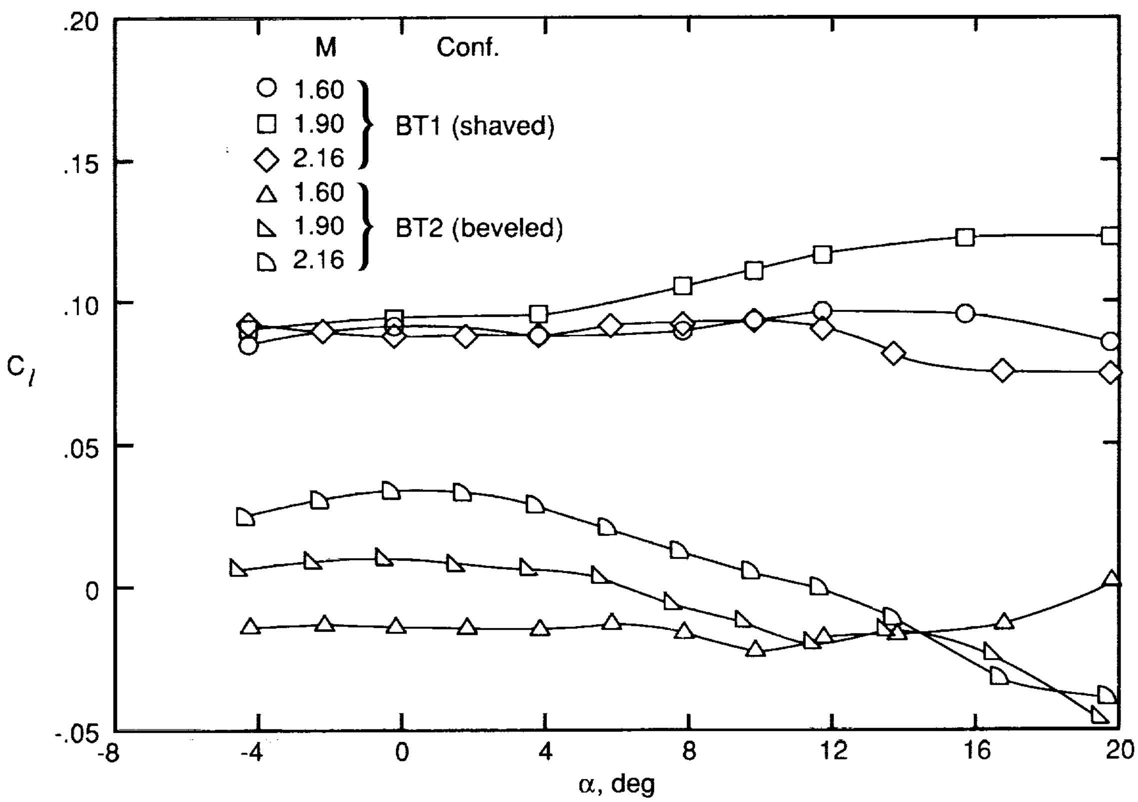


Figure 14. Summary of tail-shaping effects with $\phi = 0°$.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
November 1994

3. REPORT TYPE AND DATES COVERED
Technical Memorandum

4. TITLE AND SUBTITLE
Experimental Study at Low Supersonic Speeds of a Missile Concept Having Opposing Wraparound Tails

5. FUNDING NUMBERS
WU 505-59-30-01

6. AUTHOR(S)
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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
NASA Langley Research Center
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8. PERFORMING ORGANIZATION REPORT NUMBER
L-17337

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
National Aeronautics and Space Administration
Washington, DC 20546-0001

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
NASA TM-4582

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Unclassified–Unlimited

Subject Category 02

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*
A wind-tunnel investigation has been performed at low supersonic speeds (at Mach numbers of 1.60, 1.90, and 2.16) to evaluate the aerodynamic characteristics of a missile concept capable of being tube launched and controlled with a simple one-axis canard controller. This concept, which features an axisymmetric body with two planar canards and four wraparound tail fins arranged in opposing pairs, must be in rolling motion to be controllable in any radial plane with the planar canards. Thus, producing a constant rolling moment that is invariant with speed and attitude to provide the motion is desirable. Two tail-fin shaping designs, one shaved and one beveled, were evaluated for their efficiency in producing the needed rolling moments, and the results showed that the shaved fins were much more desirable for this task than the beveled fins.

14. SUBJECT TERMS
Tactical missiles; Low supersonic; Stability and control; Wraparound fins

15. NUMBER OF PAGES
55

16. PRICE CODE
A04

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	